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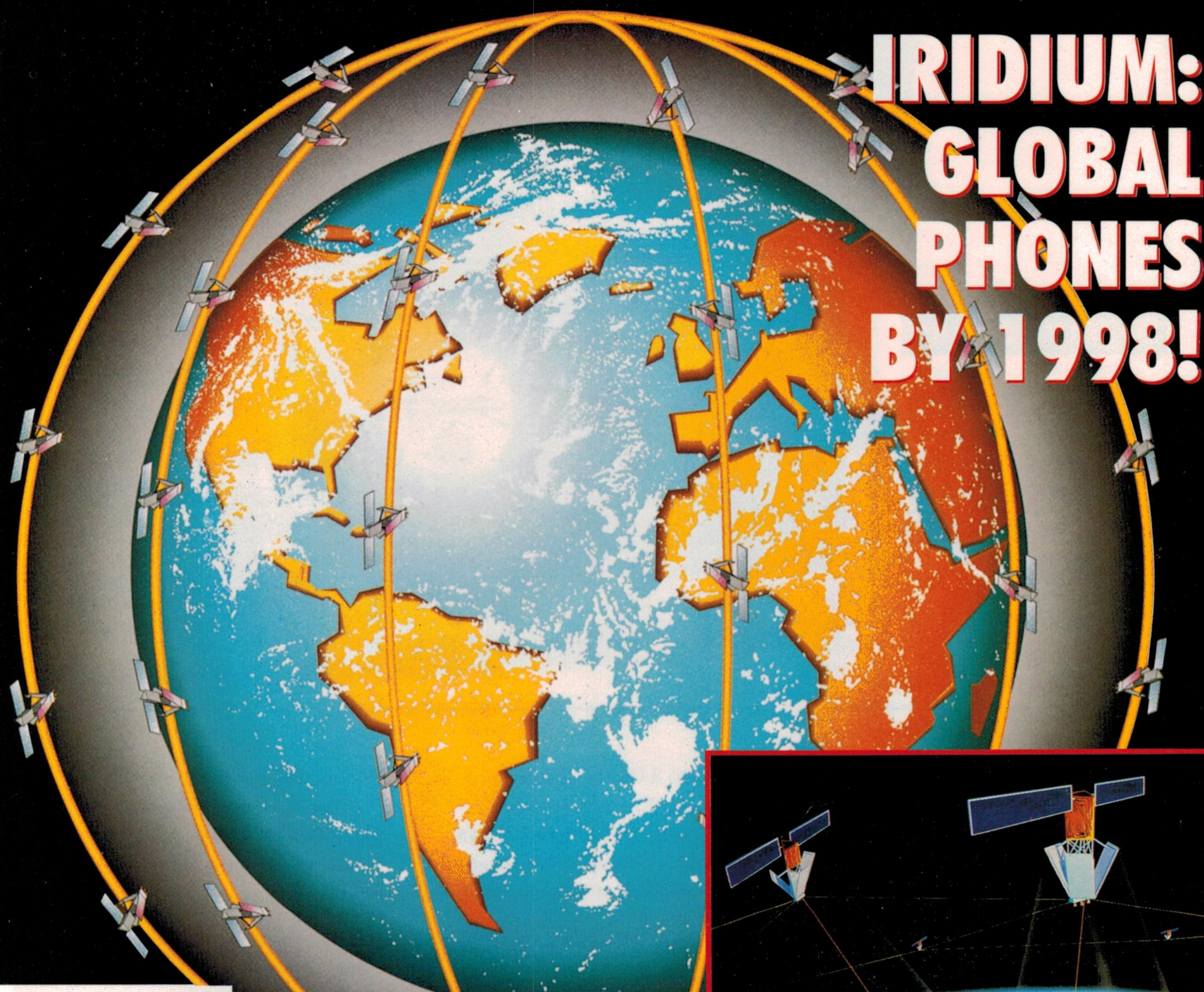

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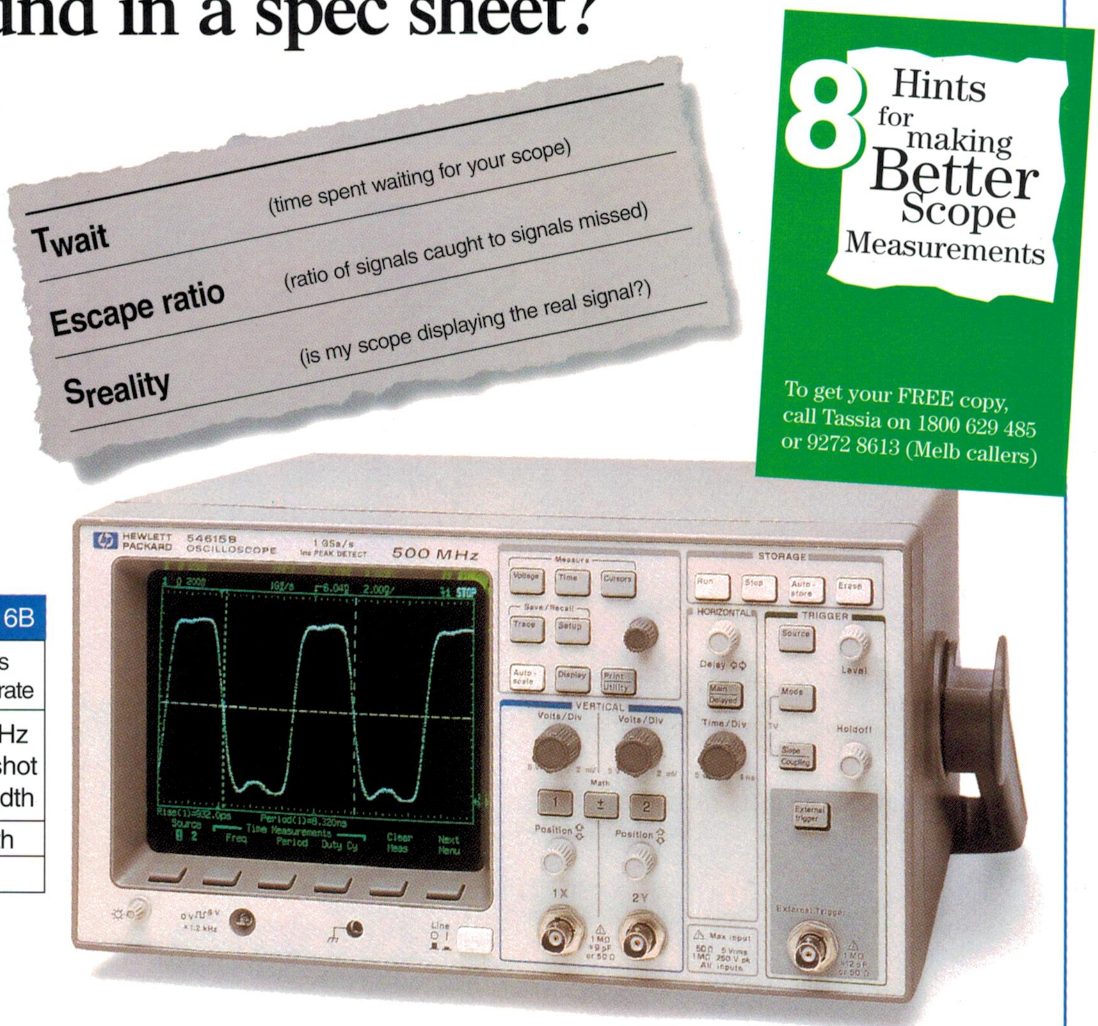

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Volume 58, No.9
September 1996

Electronics

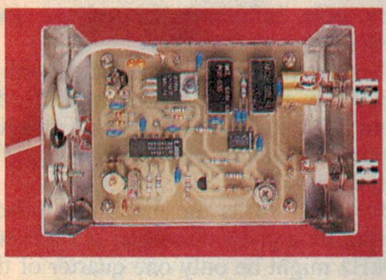
AUSTRALIA with Professional Electronics & ETI

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Unusual headphones

This month Louis Challis has been testing the unusual Ergo Model 1 Stereo Headphones, from Swiss manufacturer Precide SA. They turned out to be very interesting, as he explains in his review starting on page 10.

Shows the LF spectrum



If you built our low cost Spectrum Analyser (September-October 1992), this month's Upconverter should interest you. It extends the Analyser's effective range down into the LF region, making it a lot more useful. See the article starting on page 60...

On the cover

Due to begin operation in 1998, the IRIDIUM system will have no less than 66 satellites in low earth orbit, to provide a satellite telephone service covering literally anywhere on Earth. It's an enormous project, and now well under way — see our special feature story starting on page 26. (Artwork courtesy Iridium Inc.)

Video and Audio

Features

Projects and Technical

Columns and Comments

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Professional Electronics

MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
TECHNICAL EDITOR
Rob Evans, CET (RMIT)
PROJECT DESIGNER/WRITER
Graham Cattley
PRODUCTION EDITOR
Witold Budzynski, B.Sc.
CONTRIBUTORS
Louis Challis
Arthur Cushen, MBE
Peter Lankshear
Jim Lawler, MTETIA
Tom Moffat, VK7TM
Peter Phillips, B.Ed., Dip Ed., ECC
Nick de Vries, MIAME, AMSAE
Jon Loughron, Assoc. Dip. Elect.
Neville Williams, FIREE, VK2XV
READER SERVICES CO-ORDINATOR
Ana Marie Zamora; phone (02) 9353 0620
DRAFTING
Drawquick Computer Graphics
COVER DESIGNER
Clive Davis
ADVERTISING MANAGER
Selwyn Sayers
Phone (02) 9353 0734; fax (02) 9353 0613
ADVERTISING PRODUCTION
Tim Cooney; phone (02) 9353 0740
PRODUCTION
Ray Eirth
CIRCULATION MANAGER
Michael Prior
HEAD OFFICE - EDITORIAL
PO Box 199, Alexandria 2015.
180 Bourke Road, Alexandria 2015.
Phone (02) 9353 0620; fax (02) 9353 0613
Subscriptions Enquiries:
phone (02) 9353 9992; fax (02) 9353 0967.
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MELBOURNE: Pilar Misa, 504 Princes Highway, Noble Park, 3174.
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BRISBANE: Graham Smith, 26 Chermside Street, Newstead 4006.
Phone (07) 3854 1119; fax (07) 3252 3692.
ADELAIDE: Sue Bowshall, 98 Jervois Street, Torrensville, 5031.
Phone (08) 352 7937; fax (08) 352 6033.
PERTH: Greg Winning, Allen & Associates, 54 Havelock Street, West Perth, 6005.
Phone (09) 321 2998; fax (09) 321 2940.

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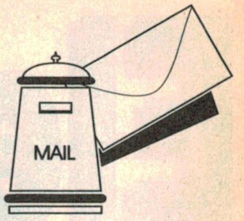
LETTERS TO THE EDITOR



PC interference

My experience in fixing interference on Channel 2 (63 - 70MHz) from my (no brand name), '486 based PC may be interesting to readers. A clear herring-bone type pattern covered the screen on my TV, and my neighbour's TV, when tuned to Channel 2.

I tried a number of things — mains filters, rabbits ears instead of the antenna on the roof — ferrite ring around power cords, all to no avail. I concluded that the interference was being radiated more or less everywhere.

I removed all cables except the power cable and fired up the PC. As I replaced each cable, I checked the TV which (to my surprise) showed interference only when the mouse cable was attached.

Thinking that it was a long shot, I grid dipped the cable to find that it resonated at about 68MHz. I bought a mouse cable extension with plans to fit some sort of filter in each wire but, to follow up the long shot, I first plugged in the extension cable. To my surprise the interference vanished. Two grid dipped resonances were at about 50 and 100MHz.

I cannot offer any sort of detailed explanation. For the sake of those with the same interference, I hope that I have stumbled across a useful solution.

Clive Luckman
Middle Park, Vic.

Feature, or fault?

I wonder if you could help solve a problem, proudly advertised as a feature in 'ARLEC Security Floodlights'. This may interest your readers as well and could save someone a large power bill.

The feature/problem is described in the instructions as follows:

To override the 'automatic' mode, (i.e. operation of the motion sensor) switch the mains 'off and on' within two seconds. The security light will now stay on continuously. To return to 'automatic', interrupt the mains for at least ten seconds.

In other words, if you are on holiday and the power fails for a second or so, a 300 watt load (two floodlights) will stay on until the power fails for more than ten seconds. (The designer must have had a brainstorm.)

The AC input section is very marginal as well, and so is the relay. Aren't we checking imports to suit Australian Standards, or are gadgets that have the USA stamp good enough for us?

Wolfgang Melchhart
Westmeadows, Vic.

Power response?

In the June 1996 issue of EA you have a description of a 50 watt/channel amplifier with performance details on page 55. Fig.7 is a graph of what you have labelled the '*power response* of the amplifier with the tone controls bypassed'. Surely the graph is of the frequency response of the amplifier, and which is a completely different parameter.

The frequency response is the voltage gain of the amplifier as a function of frequency and should be measured at about 10dB below the rated power output of the amplifier (to ensure that the voltage gain is not affected by overload at any frequency). The power response of an amplifier is the power output for a specified distortion as a function of frequency.

Obviously the power response is not affected by the tone controls, because they only influence the voltage gain with respect to frequency.

You could have an amplifier with a frequency response that is within 1dB from 20Hz to 30kHz, but which also has a power response that is -6dB at 20Hz and 30kHz.

In other words the maximum power output for a given distortion at 20Hz and 30kHz might be only one quarter of the power output measured at a mid frequency of 1000Hz. Power response and frequency response are two entirely different parameters and often the source of much confusion.

Certainly the frequency response of a 50 watt amplifier should never be measured at an output of 49 watts.

Neil McCrae
East Hawthorn, Vic.

DSE's response:

We agree that the graph shown does not fit the definition of power response used by Mr McCrae. It might be better described as a graphical representation of power bandwidth, which National Semiconductor defines as 'the frequen-

cy range over which the amplifier voltage gain does not fall below 0.707 of the flat band voltage gain specified for a given load and output power'. This term is used to describe such graphs in audio design articles published in the respected English journal *Electronics World + Wireless World*.

Certainly in the past, many amplifiers were incapable of delivering full power output over a wide frequency range, predominantly due to slew rate limitations. The practice of measuring frequency response at low power levels yielded better figures than did full-power measurements.

It is a tribute to modern audio technology, such as that employed in the Stereo Control Amplifier, that in contrast with Mr McCrae's closing statement, the frequency response of well-designed audio amplifiers *can* be measured at full output.

Rex Callaghan,
Technical Services Manager
Dick Smith Electronics
North Ryde, NSW.

Filter unsafe

I've just finished looking through the July issue. While reading the power filter article, I noticed one potentially lethal error in the design.

The bolts used to attach the mains socket to the case are made of steel. While one of them is earthed, the other is electrically unconnected. Should a fault occur, such as the active line coming adrift and coming into contact with this bolt, the latter would become live and extremely dangerous.

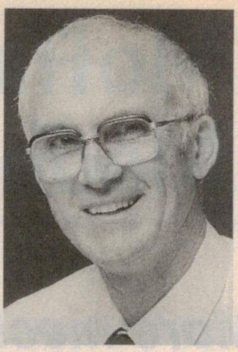
Given the level of debate on electrical safety that has appeared in yours and other similar publications in recent times, I find an oversight such as this to be quite amazing. I would suggest a correction be printed in the next issue to highlight both the danger and the simple remedy of using a nylon bolt in place of the steel one.

Lance Turner
Glen Iris, Vic.

Because of the construction used, the risk of the second screw becoming 'live' seemed extremely small, Lance. However we agree that the use of nylon bolts would certainly reduce the risk even further. Thanks for your concern. ❖

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of Electronics Australia. We reserve the right to edit letters which are very long or potentially defamatory.

EDITORIAL VIEWPOINT



Reflections on the V chip, and a grateful farewell...

It's been interesting to see the comments that have been made, ever since Communications Minister Richard Alston announced that the Federal Government would be making it mandatory for new TV receivers sold in Australia to be fitted with the so-called 'V chip'. The response has been quite mixed, with seemingly almost as many people opposed to the idea as there have been in favour.

The essence of the V chip concept seems to be that all video program providers are required to electronically 'tag' each program with a classification code, transmitted in the vertical blanking interval like the existing VITS signals and Teletext/closed caption information. Receivers fitted with the V chip can then be programmed by a parent to prevent viewing of programs with certain classification codes, thereby controlling what their children can view.

Considering the increasing level of violence in the movies, it's understandable that parents are seeking this kind of help from technology. In principle it sounds reasonable enough, too — although as many people have pointed out, it's only new sets that will be fitted with the V chip. Older sets will lack the chip and accordingly display every program — which means that if people pass their existing set on to their kids (as many do) when they buy a new one, they'll defeat the purpose. There's also the problem that in many households, youngsters are better able to program new technology than their parents. This could well mean that either the kids end up programming the V chip, or at least work out how to reprogram it. Either way, the purpose would again be defeated...

I notice from recent issues of US magazines such as *EDN* that virtually the same controversy has been raging over there as well. Many Americans also seem to be worried that the V chip could allow Governments (including their own) to perform covert censorship of programs for adults. I'm not sure whether the technology would even allow this, although it's perhaps not impossible. I guess most of us would be concerned if the system is capable of this kind of 'big brother' manipulation.

Mind you, developments such as the Internet/World Wide Web and interactive multimedia could well make it very difficult to achieve the kind of control that the V chip proponents are aiming for — unless the Government is proposing that all computers have to be fitted with a V chip as well. Now that *would* be controversial!

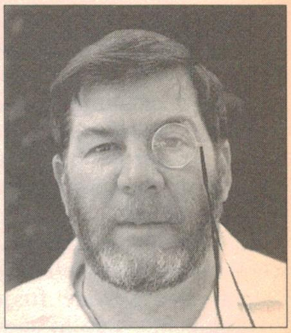
Before closing, can I draw your attention to the fact that this issue carries the last of our Vintage Radio columns to be written by contributor Peter Lankshear. After launching the column for us back in June 1988, Peter has laboured every month to provide interesting and popular episodes. But now, with episode 100, he has decided to 'call it a day' and take things a little easier. I'm sure you'll join with us in thanking Peter for all the effort he put into those 100 columns, and also in wishing him all the best for the future.

Have no fear that the Vintage Radio column itself is ending, though. Next month our new columnist Roger Johnson takes over, and Roger assures me that he has plenty of interesting topics planned. So stay tuned!

Jim Rowe

Moffat's Madhouse...

by TOM MOFFAT



More mechanical MIDI music mayhem

Thought you were rid of MIDI stuff after the April issue, right? Wrong, because that was only the start. Some things are developing in the MIDI field, along with the mechanical music area, that bear reporting. For mechanical music enthusiasts — lovers of pianolas and the like — what follows is excellent news indeed.

In the March and April issues of *EA*, we touched briefly on how you can use a MIDI keyboard or module, along with a personal computer, to make your own pianola or nickelodeon, or even simulate the fine old DeCamp Robot Dance Orchestra that lives in Sydney. But, it turns out, we were only scratching the surface.

Anyone who was ever a kid, and that includes most of us, would have come across an old time carousel or merry-go-round at some time or other, at a circus, in a place called Luna Park or even Disneyland. The centrepiece of these machines was always a huffing, snorting music machine that played the appropriate ooom-pah music as the horses went round and round and up and down. No self-respecting carousel back then would allow one of those new-fangled 'amplifiers' attached to loudspeakers. Legitimate carousels got their music from a thing called a 'band organ'.

The proper name is 'military band organ', because these machines were designed to produce the entire sound of a full marching band, powered by air pressure under the direction of a perforated paper roll. The sounds came mostly from reeds, like in an enormous accordion. There were also bells, and horns. (One excellent air-horns-only mechanical organ was blasting away in Sydney's Powerhouse Museum last time I was there.) All this stuff was housed in an ornately carved and painted box, usually topped by a whacking big bass drum.

The king of all these contraptions was the Wurlitzer Style 165 'Orchestral Duplex' band organ, advertised as 'suitable for the largest type stationary Carousels, Roller Coasters and other Park installations'. The instruments were made from around 1914 until 1939, when the last of them was installed in a merry-go-round in Los Angeles.

Now there are fewer than a dozen of these Wurlitzers in existence, and given their age they must all expire eventually. One precious machine was even destroyed by fire in 1994. But that's not the end of Wurlitzer band organs by any means; they are being brought back to life courtesy of MIDI music modules, the personal computer, and a handful of dedicated enthusiasts.

I recently stumbled upon a MIDI file which is a simulation of a Wurlitzer 165 band organ in full bellow; a recording of an old-style American patriotic song called 'Painting the Town Red, White, and Blue'. It's a cross between a march and a ragtime tune, typical of the music of the World War One era.

As mentioned in the original MIDI articles in *EA*, a typical MIDI musical instrument can play up to 16 instruments at once from a collection of 128, including most band and orchestra instruments, and things like pianos, guitars, and drums. In a top-line MIDI device the instruments are not synthesized; they are actually recorded, sampled, and digitized into some ROMs in the MIDI unit. In other words, the instruments are the real thing.

The Wurlitzer simulation uses 13 MIDI instruments, but because of the unique sound of the band organ, the instruments are used in very whacky ways. For instance, big organs like this have very large reeds to play the bass notes, and due to their size there is a delay between when the wind hits them and when they get vibrating enough to make a sound. So each bass note is kind of a 'whoof'.

In the MIDI band organ, these bass notes come from an alto saxophone played two octaves too low — something a real alto sax couldn't do. The attack time is highly exaggerated, the notes are played only briefly, so each makes the required 'whoof' sound. Similarly, one of the soprano melody instruments is really a tuba played three octaves too high. Liberal use is also made of a pan flute, playing in several wrong registers at once. And over the top of the whole performance is a glockenspiel, tinkling along at maybe four times the pace of the main song.

Something that will make purist's skin crawl is the use of some electronic synthesizer voices to 'fill' the band organ's sound, particularly a sawtooth wave. How dare they! But — it works, and if you listen to this MIDI file on any halfway decent MIDI instrument, you'll be taken right back to Luna Park in the blink of an eye. This merry-go-round organ is almost perfect!

Actually, you WILL be able to listen to this performance. We are making this file available on the *EA* BBS; details will follow.

The background

How did this interesting band organ performance come about? First, the song: 'Painting the Town Red, White, and Blue' was written by Stephen Kent Goodman way back in 1992. Not 1892, but 1992, only four years ago. This is a significant event, because it means that people are still composing this glorious old music of the past.

Stephen Kent Goodman's big thing is writing music for concert bands and ensembles, and 'Painting the Town' was originally scored for a small ragtime orchestra (there are many of these small bands around, and there's even a string quartet in Tasmania that plays lots of Scott Joplin ragtime).

Then along came an enthusiast named Robbie Rhodes, who decided to arrange 'Painting the Town' for Wurlitzer Band Organ, beginning with a MIDI file. Although there are computer-driven roll cutting devices for piano rolls, which work from MIDI files, nothing was available for the band organ format. So Robbie's only option was to attack the problem with a long roll of blank paper

and a knife. Too hard!

Instead, Robbie Rhodes enlisted fellow enthusiasts David Wasson and George Bogatko to manufacture a Wurlitzer Band Organ within a Roland Sound Canvas MIDI module player, based on the Robbie Rhodes MIDI file for piano roll cutter. It was a roundabout method, but they got there.

In the original *EA* MIDI articles, I said that it seemed the MIDI player, combined with a computer, was becoming the modern-day equivalent of the pianola. And it looks like I wasn't wrong; since those articles were written hundreds, maybe thousands, of electronic 'piano rolls' have become available, mostly on the Internet. One of these is a real mind-snapper; it's not one pianola, but two of them, going at it simultaneously — a two-player, piano duet.

Again this is a modern tune called Bucktown Buck, composed in 1993 by Frank French. The song first surfaced on a CD called *Bucktown in the 90's*, a collection of piano duets performed (on real pianos) by Frank French and Scott Kirby. Bucktown is near New Orleans, the stomping grounds of Jelly Roll Morton whose style inspired the tune.

Driving two pianos

A ragtime enthusiast named John Roache was so taken by Bucktown Buck that he sat down at his MIDI computer and constructed a piano-roll style sequence of the whole performance, with MIDI commands flying out to two pianos at once; one a honky-tonk piano and the other the MIDI 'bright acoustic' piano.

How could any one person do that? It sounds like so much work — there must be many hundreds of notes in Bucktown Buck. Well, I took the bull by the horns and managed to track down the pianist/constructor/programmer of this performance, to find out how an expert does it. MIDI enthusiasts take note!

Let the man introduce himself: "My name is John Roache. I am an amateur ragtime enthusiast living in Torrance, California. I have been playing piano and keyboards for almost 50 years. I began creating ragtime computer music in the mid-'80s on the Commodore-64 using the SIDPLAYER music composition program. In 1994, I began to discover the power of MIDI and have been sequencing ragtime, stride and swing music since then."

Yes, but HOW? With the help of some snazzy software, *Cakewalk Pro*, and a SoundBlaster AWE 32 sound card, that's how. There are several ways to get the music into the computer. The 'top of the line' method is to run a piece of sheet music through a scanner, and then use optical character recognition to transfer notes from the sheet music into the software score editor.

If you are a musician (and it seems many MIDI enthusiasts are), you can sit down at the keyboard and play your music into the computer. Since the editing software is like a multi-track tape recorder, you can split up the job and play the left hand part onto one track, using both hands, and then play the right hand part onto another track again using both hands. This simplifies things, but you still have to be a reasonable musician to do it.

So, for something like the Bucktown Buck duet, you end up with four tracks — left hand first guy, right hand first guy, left hand second guy, and right hand second guy. These are probably rough and ready at this stage, full of mistakes, and here is where the real work begins.

Almost every MIDI software package includes a 'piano roll editor', in which the notes are displayed as 'holes' in a roll of 'paper' on the screen. As the music plays the 'paper' moves along sideways. The hole positions up and down the screen represent note pitch, the holes' length represents the length of the notes, and their position left or right represents the order they appear in the song. (There's a photo of this on page 22 of the April issue of *EA*.) Since John Roache concentrates almost entirely on piano roll arrangements, he uses the piano roll editor exclusively:

"Editing a sequence for piano roll arrangements is exactly the same as was done when the old piano rolls were created. The piano roll was created by a performer playing on a 'recording' piano which created a punched paper roll. This paper master was then manually 'edited' by taping over mistakes and manually punching in corrected notes and adding more notes to fill out the arrangement. Midi sequences are edited exactly the same way, except it is all done digitally in the computer instead of manually on a paper roll."

More notes to fill out the arrangement! Now we know the secret of why piano rolls sound like piano rolls. The piano roll arranger has taken certain liberties to jazz up the song a little. A few extra notes here and a few there, and let's throw in an extra run, or maybe several. The resulting production sounds absolutely spectacular, but it's now unplayable by a human pianist. The tune exists only within a mechanical piano (or a computer).

What all this means is that those fabulous mechanical music machines of the past are not dying after all. They're being reconstructed electronically by modern-day people like Robbie Rhodes and John Roache, using their clever computer and music skills. And we have composers like Stephen Kent Goodman writing new material in the old style. I guess these people are our 'music archaeologists'.

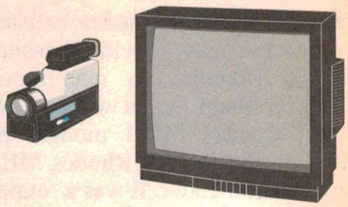
Now it's 'where to get it' time. We have posted the two MIDI files mentioned here on the *Electronics Australia* computer bulletin board, on phone number (02) 9353-0627. Look for the filename 'MADMIDI.ZIP'. Note that these are very complex tunes, and they won't play on any sound card or synth with less than 20 voice polyphony. Be sure to fasten your seat belt before playing, and turn the volume up LOUD, especially for the band organ.

Finally, here are a couple of useful Web sites on the internet:

'**http://pages.prodigy.com/trachtman/**' takes you to Warren Trachtman's Ragtime MIDI page, which is absolutely chock-a-block with MIDI piano rolls.

'**http://members.aol.com/ragtimers**' is John Roache's home page; it's got lots more of his excellent piano roll sequences of both classic ragtime and the latest modern material. ❖

What's New in VIDEO and AUDIO



Home Theatre loudspeakers

Sydney based loudspeaker system manufacturer Audiosound Laboratories is now able to offer complete packaged systems for 'home theatre' and other surround sound applications. The systems are based on some of Audiosound's existing systems, with the addition of a newly designed, double magnetically-shielded, cohesive point source centre channel system, the CE-1.

The CE-1 is a passive equalised single unit system offering very cohesive point source speech reproduction for the centre channel.

At present there are three packages available (systems 1, 2 and 3), each comprising front, rear and centre channels and claimed to offer excellent value compared to purchasing the units separately.

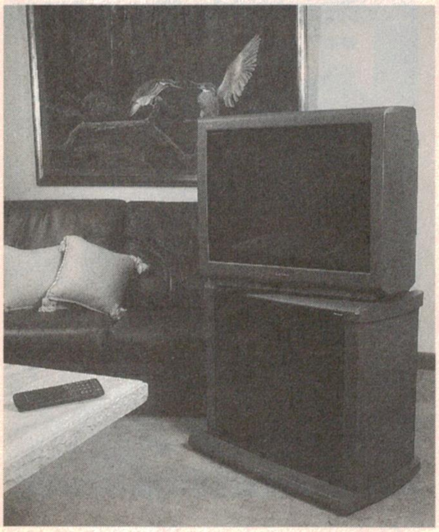
System 1 is very unobtrusive, yet full of impact. It uses the 'space-bass' system incorporating two subwoofers (seven speakers in all), for under $2000. The total system comprises the space-bass set, two tiny satellite speakers and two subwoofers plus two matching tiny DM-1s for the rear, plus the new CE-1. The tiny up-front and rear speakers come with wall mounting brackets and can be colour matched to order for an almost invisible total system.

System 2 uses floor-standing 8015's up front, with their Piccolo system for rear channels and the CE-1 for the centre. The 8015s have received an Australian Design Award. This complete package is economically priced at $1890.

System 3 is similar to System 2, and the same price, but uses unobtrusive DM-1's instead of Piccolo enclosures for the rear channels.

For more information circle 143 on the reader service card or contact Audiosound Laboratories at 148 Pitt Road, North Curl Curl 2099; phone (02) 9938 2068.

Large-screen CTV from Mitsubishi



A new large screen colour television from Mitsubishi Electric is claimed to make home theatre worth considering and big screen TV more affordable. The firm's 33" (78cm) New DIVA (CT-33AC2SL) has an RRP of just $3299, said to make it one of the best value sets on the market.

The Symphony Sound System on the New DIVA includes a Super Woofer for enhanced bass with low distortion. A well balanced picture is achieved using AI (artificial intelligence) Fuzzy Logic circuitry. The TV takes a viewer's distance from it into account, and assesses ambient light levels to automatically adjust the brightness of the picture.

An Auto Turn feature lets you turn the screen to the left or right using the remote control.

Mitsubishi Electric CTV receivers are available at all major electrical retailers nationally. For further information circle 141 on the reader service card or ring NSW (02) 684 7777; Qld (07) 3357 8813; SA/NT (08) 340 2000; WA (09) 377 3400; Vic/Tas (03) 9262 9855.

High performance DAC kit

Melbourne firm Contan Audio has released what is believed to be the first Australian designed high performance audio DAC, which is available as a kit. The unit is claimed to achieve a dramatic improvement in the performance of low to medium quality CD and DAT players. (The CD/DAT must have a digital output, either coax or Taslink.)

The design is based on the Burr-Brown PCM63P ultralow distortion 20-bit digital to analog converter, which uses colinear dual-DAC architecture to provide a guaranteed THD and noise level of -88dB. Even better performance (better than -96dB) can be achieved using the enhanced PCM63P-K. The input receiver uses the Crystal Semiconductor CS8412P, which has excellent jitter performance.

The Contan PCB offers a choice of two alternative 8x oversampling digital filters: Burr-Brown's DF1700P (bandpass ripple .00005dB, stop attenuation 110dB, no digital de-emphasis), or Nippon Precision Circuits' SM5842AP (bandpass ripple .00002dB, stop attenuation 117dB, automatic digital de-emphasis correction).

Other features include socketed output op-amps to allow experimentation, a separate +/-15V power supply for the op-amps, and indicator LEDs for 'synchronous lock-in' and de-emphasis.

The basic PMDAc-1 kit, with twin PCM63P DACs and DF1700P filtering, is priced at $413. The PMDAc-2 kit with the enhanced PCM63P-K DACs is $488.

For further information circle 144 on the reader service card or contact Contan Audio, 37 Wadham Parade, Mt Waverley 3149; phone/fax (03) 9807 1263.

Digital camcorder released by Panasonic

A new era in consumer video has arrived with the Panasonic NV-DX1 digital camcorder, which is claimed to offer broadcast quality in a compact, easy-to-use unit. Previously digital video camera/recorders were large and limited to professional applications.

The NV-DX1 uses a new format known as DV (Digital Video), which enables digital recording on a cassette half the size of an 8mm video cassette. DV is a worldwide format supported by 56 companies. Although all video equipment in the DV format is compatible, there are differences in product construction, quality and ease-of-use. Panasonic has decided to give all of its DV format products the name Digital6.

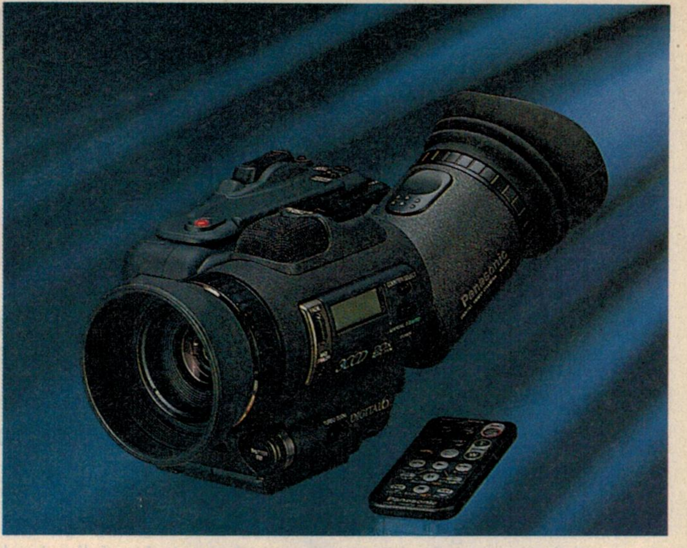
The DX1 is Panasonic's first such product, and features three-CCD imaging technology like that used in professional broadcasting equipment. A timebase corrector (TBC) is a standard feature of the DV format, reducing horizontal jitter by compensating for any irregularides in the time axis. The format also includes an error correction function that minimises dropout and assumes recording and playback reliability.

With 500-line horizontal resolution capability, DV brings crisp detail far exceeding the 400 lines offered by Super VHS and Hi-8.

High quality digital sound supports the outstanding digital picture quality. Recording is possible in two modes: two channels with 48kHz 16-bit sampling for DAT level sound quality, or four channels with 32kHz 12-bit sampling which provides two channels for original sound recording and two more channels for audio dubbing. If the user shoots in 12-bit dual stereo, background music or narration can be added later without affecting the previously recorded audio or picture. Inserting new images in the middle of recorded sequences is also possible without replacing the original sound.

The 6 - 60mm (10:1) range of the DX1's optical zoom lens can be digitally extended up to 20:1. A turbo zoom button allows the user to adjust from full wide-angle to telephoto in just 1.9 seconds.

The DX1 also has a large, multi-angle colour viewfinder which is adjustable for high angle or low angle shooting. It has a wide magnifying lens (39mm diameter) allowing the user to view the image with the eye off the eyecup.



Three manual exposure settings, in addition to an automatic setting, easily adapt to a wide range of lighting situations. Manual adjustment is highly accurate, based on the information from the three CCDs, iris data and an AWT (auto white tracking).

The DX1's manual focus uses the ring system commonly found in professional equipment.

Fast-forward and rewind of tapes is 60 times the normal speed and a 60 minute tape can be rewound in 80 seconds. Digital searching at 10 times normal speed shows a clear picture free of noise bars. The Digital Photo Shot feature takes a high resolution still shot with about seven seconds of sound. One 60 minute tape can hold 500 stills.

The DX1 is compact and lightweight. It weighs only 1.2kg with the battery pack and tape loaded. The rigid polycarbonate ABS alloy outer case resists heat and shock. An internal lithium-ion battery power enables 60 minutes of continuous recording or 180 minutes when using both the internal and an optional external battery.

The RRP for the Panasonic NV-DX1EN digital camcorder is $6099, and it is available from leading electrical outlets. For further information circle 140 on the reader service card or contact Panasonic's Customer Care Centre on 132 600.

High quality equipment racking

A new high quality, heavy duty equipment racking system has been introduced by South Australian firm A&R Woodcraft, which has gained an enviable reputation as a manufacturer of quality cabinets for the specialist audio industry.

The recent trend in the hifi market towards Home Theatre systems has drawn attention to the lack of suitable high quality racking in Australia. This prompted A&R Woodcraft to develop its new Stand Alone (SA) racks, which are claimed to provide performance, style and versatility to suit most applications.

The SA racking systems are available in three standard sizes that all incorporate solid timber construction, a quality textured black painted finish, 60kg shelf capacity and adjustable shelf positions. They can be fitted with either 50kg castors or adjustable spikes, and the smaller designs can be expanded easily. All systems are available conveniently packed in kit form.

The systems are also very reasonably priced, and start at $399 for the SA400 three-tiered unit. The larger SA700 three tiered unit is $449, while the largest four-tiered SA1000 model is $499.

Optional timber finishes are now also available, in Australian Jarrah or Australian Oak, at extra cost.

All SA Rack Systems can be purchased direct from the manufacturer by a fail-safe seven day money back guarantee mail order, using Visa, Bankcard, Mastercard or Money Order. Adelaide customers may also view and purchase the racks from Grenfell Hi-Fi and VAF Research Pty Ltd.

For further information circle 142 on the reader service card or contact A&R Woodcraft, 5A Turin Place, Salisbury South 5108; phone/fax (08) 285 7755. ❖

ERGO STEREO HEADPHONES MODEL 1

Swiss manufacturer Precide SA attracted considerable interest at this year's Consumer Electronics Show in Las Vegas, with its new Ergo loudspeakers and stereo headphones using Heil high-velocity drivers. Although Louis Challis originally thought he'd be reviewing the new Heil headphones for us this month, he was sent the earlier Model 1 phones. They turned out to be very interesting, all the same...

What constitutes good sound reproduction, and the means of achieving that aim? These ideas have undergone so many changes in my lifetime that it is with some temerity that I raise this issue here in reviewing the Ergo headphones.

In the late 1920s, my father purchased his first pair of headphones. They were the electro-acoustic transducers for his first three valve do-it-yourself 'wireless set'. He embarked on the construction of that wireless following his belated success with a crystal set (for which he borrowed the headphones from a neighbour). Both the wireless and his trusty old headphones worked moderately well until he surmounted the rigours of the depression, and purchased a superb Gulbransen seven valve radio in the late 1930s.

I discovered that old three valve wireless set and its headphones gathering dust in the back of the garage at the end of the 1940s, when they became another toy.

My father related to me how his headphones provided him with one of his rare opportunities to escape from life's troubles and tribulations into a private world of listening pleasure. But that original set of headphones was rudimentary by today's standards. Their electro-acoustic quality hardly rated a comparison with the quality dynamic loudspeaker in his seven valve radio. That of course mattered little to my father; his listening experiences were private and personal. He could relax in his own private world, free from the social pressures and constant demands of a large and hungry family.

The frequency response of the old headphones was no better than the earpiece in a telephone set of the day, with an output that was far from flat over the critical 250Hz to 3kHz frequency range. The three valve 'wireless' most probably had difficulty achieving even that order of bandwidth; in those days, expectations and demands were far lower than those of today.

The Ergo Model 1 stereo headphones are unusual in shape, as you can see. The headband is very wide, well padded for comfort and adjustable in terms of height above the transducers.

Essential for recording

Most professional musicians find that a good set of headphones still constitutes an essential requirement during recording sessions. When worn, they provide the wherewithal to hear the wanted sounds at any level without those ear level signals leaking through to the recording microphone. During public performances, drummers frequently use headphones, even though the lead artists don't. That is because, if headphones were used by the lead artists, they would certainly attenuate and potentially degrade the critical auditory information on the characteristics of the playing environment.

Most headphones exhibit subtle limitations in their low frequency sound reproduction capabilities. Thus by way of example, a good loudspeaker can deliver a bass response which few headphones can approach, let alone equal.

Between 1925 and 1975, headphone manufacturers made tremendous strides in converting those lowly headphones into a

true high fidelity transducer. The two driving forces behind those advances were Koss in the USA and Sennheiser in Germany. Whilst the two firms followed a somewhat different path, they were both successful, and their products gained considerable market acceptance.

Koss' main thrust was through the adoption of an 8Ω 'all dynamic' headphone configuration. Their most common headphone configuration used soft cushions which fitted snugly and comfortably over the ears. Their headphones were equally popular in both recording studios and for consumer applications. The sealed air volume was relatively small, and as a consequence, the acoustical coupling was relatively good. More significantly, their low frequency performance was as good, if not better than that provided by most studio monitoring speakers of the day.

Sennheiser's approach was entirely different to that of Koss. They focused their attention on the development of an 'open ear' high velocity headphone, which soon won a surprisingly large following. As well as being light, these provided acoustical transparency, and comfort levels which became the envy of their competitors.

The Sennheiser 'open ear' headphones could be used in situations where the 'real world' must be simultaneously monitored and should not be isolated. Sennheiser's secret was their development of a highly efficient, high velocity transducer system. By adopting Samarium Cobalt or Neodymium Ferrite magnets, extremely high flux densities were achieved. That ensured outstanding efficiency, with a simultaneous reduction in both the transducer's weight and size.

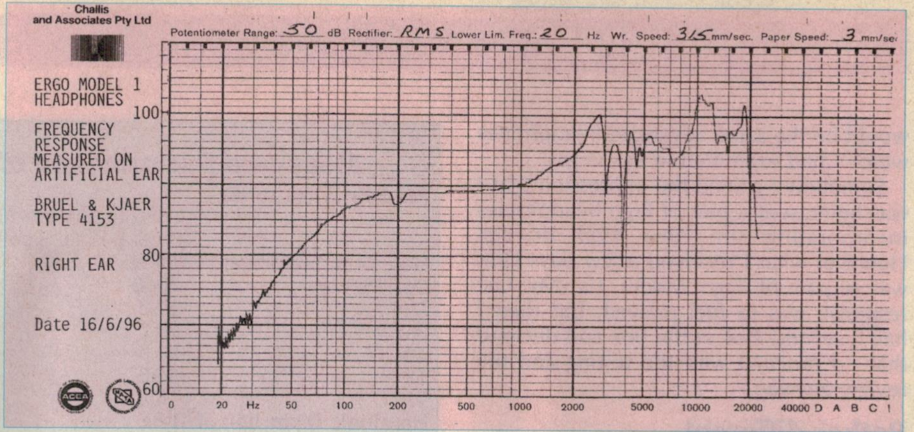
As I recall, before I seriously examined the Sennheiser design philosophy the market was being flooded with a host of 'me too' lookalikes, relatively few of which were as good as the original (let alone the subsequent) Sennheiser headphones.

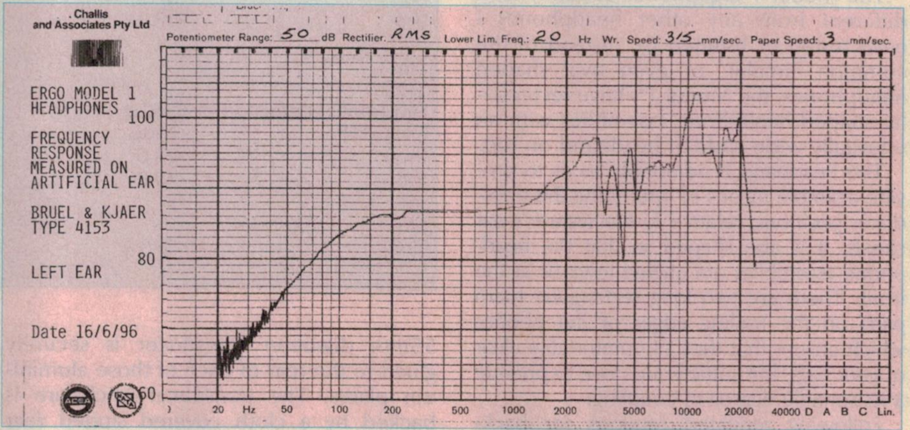
It was about that time, in the early 1980s, that the Sony 'Walkman' revolution ensued. Personal sound systems became the in thing, and most teenagers (and many joggers) were using, and enjoying their own private world of music.

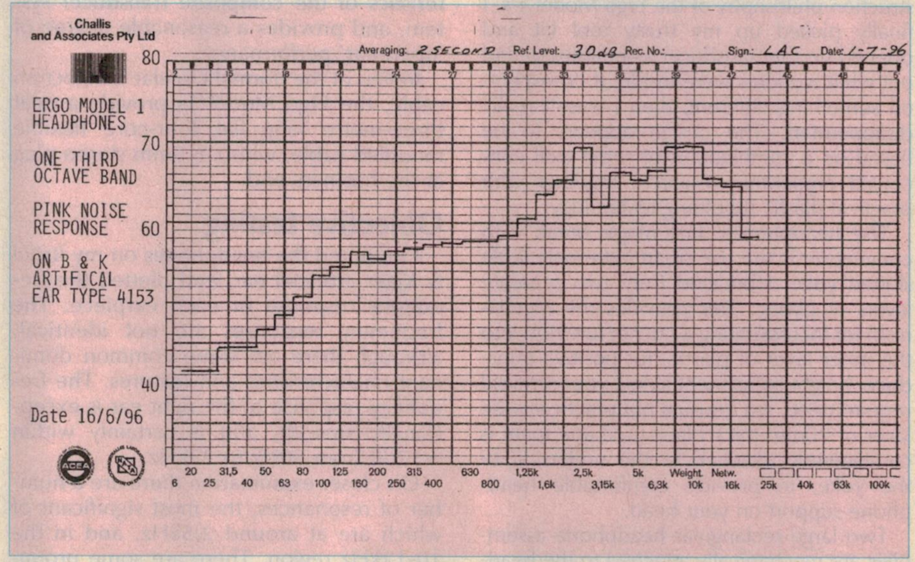
Even though Stax, Koss, Sennheiser, Pioneer and other manufacturers developed outstanding electrostatic headphones, those products were generally costly and with an added complexity associated with the need for a mains or comparatively large battery pack. The electrostatic headphones were consequently tied to the home, and to a sedentary occupation or listening environment.

Spotted at CES

Whilst touring the 'high end' exhibits at the Sahara Hotel during this year's Consumer Electronics Show (CES) in Las Vegas, I became aware of further headphone developments. I found a new headphone company, Precide SA of Switzerland, whose 'Ergo' products and name were new to me. They were exhibiting prototype







Three plots of the performance of the Ergo Model 1 headphones, as measured using a B&K 4153 artificial ear. At top is the right earpiece response, with that of the left earpiece in the centre. The lowest plot is the pink noise response with 1/3 octave band filtering. They're a 'little bright' at the high end, and modest in terms of bass, but otherwise perform well.

stereo headphones as well as loudspeakers, using Heil high velocity drivers.

Now back in the late 1970s, I purchased a pair of revolutionary 'ESS AMS' loudspeakers which used Heil dipole tweeters. Whilst the speakers were avant-garde, they certainly provided an exciting auditory experience. Their secret was the adoption of the Heil drivers, which provided clean low distortion sound of a quality simply unmatched by any other tweeter of the day.

When Audio Dynamics of Melbourne rang me recently to offer a pair of Ergo headphones for review, I asked if they

would be the same advanced headphones which I had examined in Las Vegas.

Somehow I gained the impression that I was being sent a pair of Ergo headphones incorporating the new Heil drivers. However what I received a few days later was a pair of Ergo Model 1's. My first response was to feel peeved, but then I had a second look at the box and decided that I'd proceed with the testing and the review anyway.

Rather different

The Model 1 Ergophones certainly look different from any other headphones I have tested or listened to. Instead of the common circular, or even oval shaped headphones, the Model 1's have rectangular shaped headphone assemblies with an unusually wide padded headband on top.

The headband is adjustable so as to provide a simple means of optimising the transducer positions, relative to the wearer's ear canals. It is also shaped so that the headphone assemblies are angled inwards at the front. There are two long rectangular foam pads on the trailing edges of the phones which ensure that they sit comfortably clear of your ears, but sufficiently close to provide a reasonable degree of coupling.

Following repeated requests for background information on the design and construction philosophy of the Ergo Model 1's, I finally picked up my trusty tool kit and opened up the transducer assemblies to find out what wonders were inside. If I'd expected something different, then I wasn't really disappointed. The design appears to be based on a combination of some well conceived ergonomic research, together with practical plastic moulding technology.

The headphones' first major break with convention is the use of an extremely wide slotted yoke, fabricated from two separate layers of plastic. This provides the mechanism for incorporating a ratchet function into the inner layer of plastic, for positive transducer height adjustment to suit your physical requirements. An unusual but practical wide layer of 20mm thick black urethane foam is conveniently attached to the underside of the yoke, to provide comfortable headphone support on your head.

Two large rectangular headphone assemblies are mechanically attached to the headband on both sides of the yoke structure. These assemblies are also slotted and have dimensions of 140mm x 107mm.

To avoid compressing your ears, the two 105mm long vertical pads of 20mm x 20mm urethane foam are glued to the rear trailing edges of each rectangular assembly. Their presence neatly ensures that the headphones sit comfortably on the sides of your head.

Large thin rectangular foam covered pads cover two somewhat larger finely perforated aluminium plates on the front of each of the headphone assemblies. A 55mm diameter transducer is securely glued to the rear of each of those aluminium plates. The transducer enclosure is backed by a cloth covered slotted rear cover, which maintains the dipole characteristics of the composite transducer system, and provides a reasonable degree of 'open-ear' performance.

In lieu of the normal circular connection cable, the Ergo Model 1s provide a neat three-metre long flat four-core flexible moulded cable, with a 6.5mm stereo plug at the business end.

Measured Performance of Ergo Model 1 Headphones

Frequency response
50Hz to 20kHz +13dB, -10dB, measured on Brüel & Kjaer type 4153 artificial ear (see attached graphs)

Harmonic Distortion at 100Hz			
OUTPUT	80dB	90dB	100dB
2nd	-27.8	-20.7	-16.2dB
3rd	-38.2	-28.0	-17.7dB
4th	-53.3	-41.4	-26.7dB
5th	-63.6	-43.3	-33.6dB
THD	4.2%	10.05%	20.9%
Harmonic Distortion at 1kHz			
OUTPUT	80dB	90dB	100dB
2nd	-67.0	-64.0	-61.0dB
3rd	-67.0	-68.9	-50.8dB
4th	-	-	-
5th	-	-	-
THD	.06%	.072%	0.3%
Harmonic Distortion at 6.3kHz			
OUTPUT	80dB	90dB	100dB
2nd	-70.0	-64.2	-55.4dB
3rd	-70.6	-	-64.8dB
4th	-	-	-
5th	-	-	-
THD	.045%	.035%	.018%

Objective testing

I mounted the headphones on my Brüel & Kjaer artificial ear, and plotted the frequency response of each earpiece. The frequency responses are not identical, although there are some common dominant characteristics and features. The frequency response of the right ear is exceptionally smooth, and is certainly within +12dB from 50Hz to 22kHz.

On closer examination there are a number of resonances, the most significant of which are at around 2.5kHz, and in the 10-12kHz region. There are some prominent nodes, the most significant of which are in the 3kHz and 4kHz regions.

Although the frequency response does not exhibit a particularly flat characteristic, don't be fooled. The overall frequency response is still particularly good, even though it may be a 'trifle bright' over the 2kHz to 20kHz region. An examination of the response does reveal that the low frequency response of the headphones drops off fairly rapidly below 100Hz, however. Although still useable (and even possibly reasonable) at 50Hz, the headphones are rapidly running out of steam at lower frequencies.

The total harmonic distortion characteristics of the Ergophones are reasonably good at an 80dB sound pressure level, at frequencies from 100Hz to 20kHz.

At 90dB sound pressure level, the distortion products at 100Hz are both significant and audible. However at the same output level, the distortion levels at higher frequencies are still innocuous. At 100dB sound pressure level, the low frequency distortion at 100Hz is already unacceptable but the distortion levels at high frequencies are still quite acceptable and innocuous.

I measured the pink noise response of the Ergophones, and found the overall performance mirrors the swept sinewave responses, with a significant level of brightness (and potential presence), at the top end of the spectrum.

The input impedance of the headphones is relatively high, being 240Ω at 63Hz, 170Ω at 250Hz and between 130 and 170Ω at higher frequencies.

The headphones weigh 380 grams, which is on a par or marginally heavier than other quality electrostatic headphones, with which they are capable of competing 'head-to-head'.

Subjective testing

I have not been in the habit of listening with headphones at home, even though I have many pairs, including 'open-ear', 'close-coupled' foam surround earphones and even a set of electrostatics — which although 15 years old still provide excellent performance.

Whilst Martin Durrenmatt of Precide SA in Switzerland sent me a fax providing additional information on the ability for the wearer to alter the shape of the headband with a hair dryer, I resisted the temp-

tation as I suspect most purchasers would.

Mr Durrenmatt also claims that there are positive attributes in a drooping low frequency performance, and I simply do not share that view. There are many recorded sources, and classifications of music which require (nay demand), as good a low frequency performance as possible, particularly where a simultaneous low distortion is sought.

I was fortunate to have some truly exciting music with which to audition these headphones. The first of the discs I used was a Delos Virtual Reality Recording (Delos DE 3196) featuring Andrew Litton leading the Dallas Symphony Orchestra & Chorus in Tchaikovsky's *1812 Overture*. The recording technique on this disc is outstanding. Whilst I have three other versions of the 1812, this is unquestionably the best.

Whilst the bulk of the music and singing on this disc sounded good if not excellent when auditioned through the headphones, the reproduction of 'cannon' firing was simply not in the same class as the rest of the content on the disc. However, giving the headphones their due, the other music is crisp, sharp and with a degree of presence that my monitor speakers simply do not reproduce in quite the same way.

I progressed to another outstanding disc, 'Christmas in Vienna III' (Sony SK66 846). This recording features Placido Domingo, Sisel Kyrkjebo and the famous Charles Aznavour, with the Vienna Opera Choir and the Vienna Symphony Orchestra recorded on 22 December 1994. The music and microphone techniques on this disc are also outstanding, and each of the singers is audible with a fidelity which simply has to be admired.

From the start of the first track of 'Hark The Herald Angels Sing', I was aware that this disc is special, and that the reproduction capabilities of the headphones were achieving full credit for the original recorded content. Even allowing for the presence of spatial information (the absence of which I have become reconciled whilst listening to my monitor speakers), I simply could not fault the headphones.

I progressed to a third disc, (a Sheffield Lab Audiophone Reference Series disc), featuring the famous Arnold Steinhardt on violin and Lincoln Mayorga on the piano. Twenty years ago, I (and possibly even some of you), went out of my way to purchase direct-to-disc recordings mastered by Doug Sax, and featuring Lincoln Mayorga as the pianist. Those were exceptional recordings, and indeed, this particular disc is equally exciting. It features Edvard Grieg's Sonata No 3 in C minor, Fritz Kreisler in abstracts from the operetta 'Apple Blossoms' and other delightful excerpts from Amy Beach's and Victor Herbert's fine music.

Both my family and I have gained considerable pleasure from this disc, and it certainly did not suffer to any degree as a result of being auditioned through the ERGO Model 1 headphones. If anything, I felt that the music sounded marginally cleaner, and certainly crisper than it did when compared to my monitor speakers.

The last discs that I listened to were Yo-Yo Ma's 'Great Cello Concertos' (Sony M2K 44562), featuring music of Haydn, Saint-Saens, Schumann, Dvorak and Elgar. I must agree with Martin Durrenmatt's comments that the degree of fidelity when replaying a cello recording does not suffer from the drooping low frequency response — even though Yo-Yo Ma's impeccable playing appears to be located between your ears, instead of in the normal and generally preferred position in front of your head.

In summary

The overall performance of the Ergo headphones is good to excellent on classical music, but simply not of the same calibre when listening to rock, pop or reggae music. If classical music is your bent, then you will undoubtedly like these headphones. If however pop music is your scene, then although offering good performance, they are unlikely to be perceived as outstanding.

With a recommended retail price of $299, they offer reasonably good value in terms of listening pleasure.

For further information on the Ergophones contact Audio Dynamics, of 155 Camberwell Road, Hawthorn East 3123; phone (03) 9882 0372 or fax (03) 9813 3108. ❖

NOTES & ERRATA

Low Cost RF Test Oscillator (May/June 1996): There were a number of confusing discrepancies between the schematics, the PCB overlay diagram and the parts list, regarding the main PCB.

In the schematic of Fig.1 (May article, page 58), the 0.1uF capacitor labelled C26 should be shown as C29; the 22nF capacitor shown as C29 should be shown as C30; the 0.1uF capacitor shown as C30 should be shown as C31; and the 0.1uF capacitor shown as C31 should be shown as C27. Resistor R39 should also have a value of 180W, not 150W.

In the PCB overlay on page 62 of the June article, R35 should be shown as R34 (220W); R39 should be shown as R35 (1M); R38 should be shown as R39 (150W); and R33 should have a value of 15k, not 33k.

In the parts list (page 61, May article), there should only be one 4.7k resistor — R18. Also C15 and C16 should be shown as MKT capacitors having a value of 4.7nF, not 0.1uF; and C20 should be shown as a 2.2uF 16VW tantalum. As noted in the second article, U12 (TL 072) was also omitted from the parts list.

Our apologies for the discrepancies and confusion. ❖

Product surveillance tagging technology:

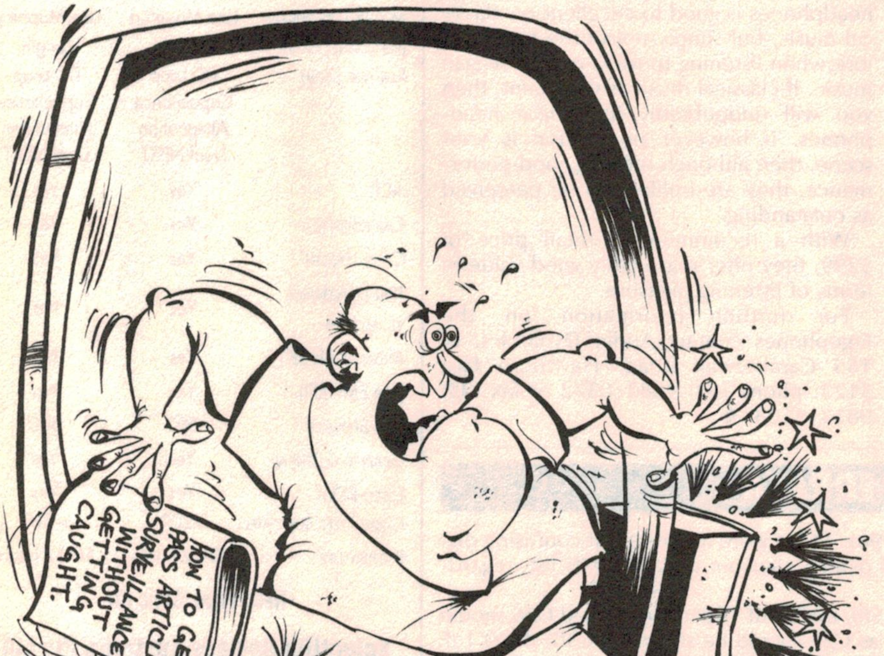
HOW YOU GET BUSTED FOR SHOPLIFTING

We've had quite a few requests for an article discussing the basic technology being used by retailers to protect against theft of merchandise. Tracking down this information turned out to be surprisingly difficult, but at some risk to his reputation Tom Moffat was able to come up with this report. We present it purely to satisfy your technical curiosity.

by TOM MOFFAT

"If that thing beeps at me one more time, I'm gonna SUE you! I MEAN it!" Ah, another happy customer heading out the door of the local variety store. The shop has recently installed one of those contraptions that detects goods accidentally leaving the store prior to payment for them.

This particular gadget seems to have taken a liking to a crusty old lady who may have some metallic body part — perhaps a replacement hip? Every time she walks past it, the machine erupts in a beeping frenzy. The old lady freezes beneath the flashing red light, and everyone now knows she is a SHOPLIFTER!



I witnessed this performance while standing in the checkout queue. It was a short-staff day, and the manager himself was working the till and copping the abuse from the old lady. I was tempted to tell him: "I'm an electronics guy, and I might be able to help you sort out that machine..."

Trouble is, to do the job properly, the first order of business would be to disassemble the old lady to see what's causing the alarms. I don't think she would be too keen on that, either. Still, it would be an interesting prospect — I've always wondered how those shoplifting detectors work. That's how this article came about.

Now, after a rather difficult research effort, we can reveal some of their secrets. For academic interest only, mind you!

In what I'd call 'Phase One' of my preparation for this article, I struck a brick wall. Nobody wants to talk about those store alarms, particularly to some fellow who intends to write about them in a public magazine. If you want to see something funny, just walk into your local shop and say "Do you mind if I take some pictures of that detector thing in the doorway?" You won't be shown the detector — only the door.

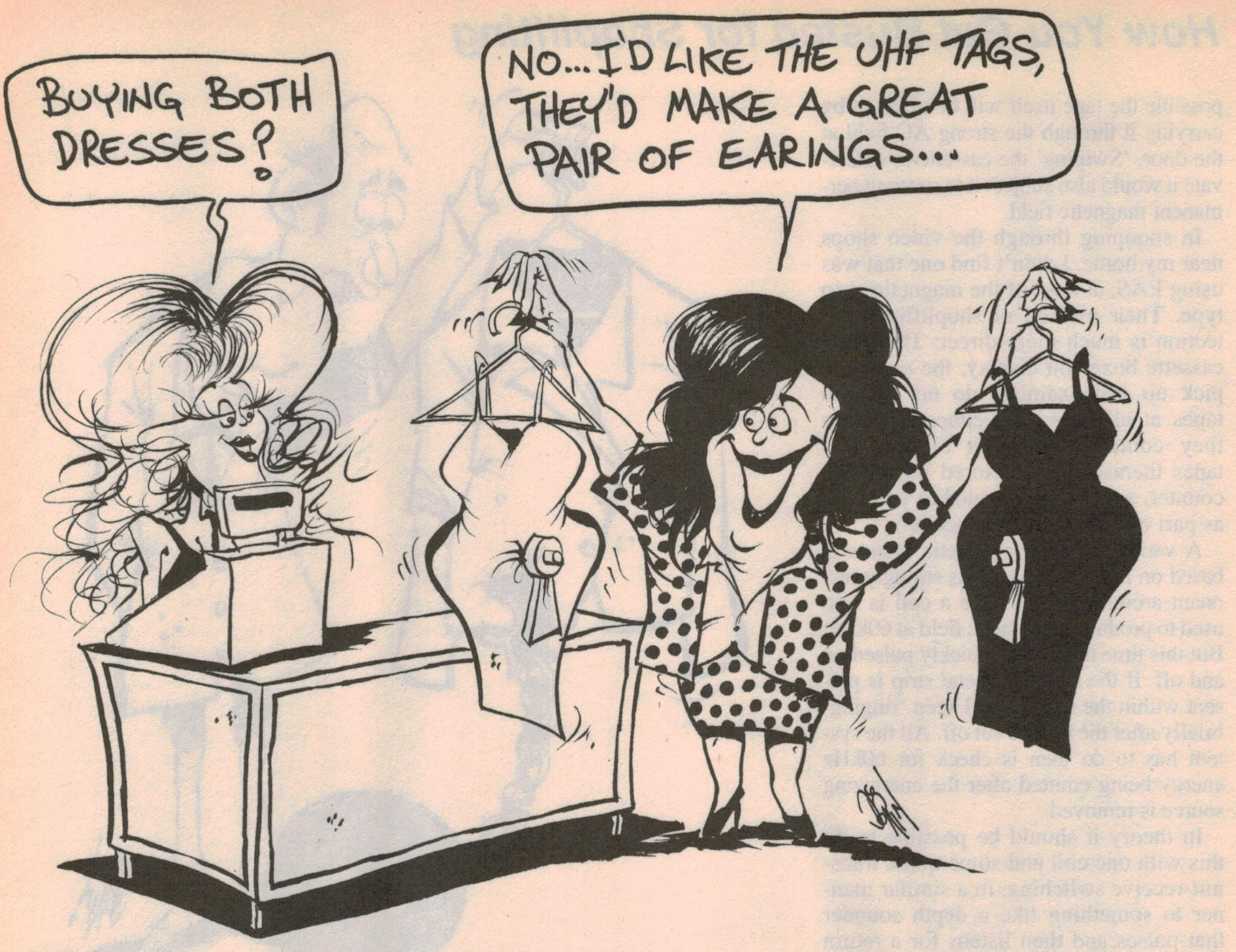
I discovered the names of a couple of manufacturers of detectors, so I sent them some polite faxes mentioning that I was researching a magazine article and would like some technical information about their products. The result was a stunning silence, in both cases. I guess I could have claimed I was a technician hired to repair a detector, but that would be dirty pool.

Not to worry. Useful information about lots of things can be gleaned from the many alternative sources that flourish here in the USA. So what follows is 'unofficial', not sanctioned or admitted to by anyone.

A lot of it was determined experimentally, but the results add up nicely. And from an electronics point of view, it all makes good sense. In other words, absolute accuracy is not guaranteed, but it's pretty likely we're very close to the mark. I suspect there won't be too many complaints about accuracy, because anyone who says we're wrong will be obliged to tell us what's right...

Article surveillance

The whole science of protecting stores against shoplifters comes under the head-



ing of Electronic Article Surveillance, or EAS. The general technique revolves around attaching an electronic 'tag' of some kind to every item sold in the store. When the customer pays for the item at the checkout, the tag is then either deactivated or removed. The removable tags have fasteners which can only be dislodged by a special tool without destroying the item.

EAS systems fall into two major categories: those based on magnetic metal strips, and those based on a tiny UHF antenna and a diode. Before going into detail about their principles of operation, let me point out **emphatically** that this information is not intended to aid anyone in defeating shoplifting detectors. Should you be caught trying to nobble one, I'm sure some store would just love the opportunity to make an example of you, and charge you with every violation in the book.

Magnetic strips

These metal strips are long and thin, perhaps up to 300mm long and 12mm wide. They are used primarily in libraries and video stores, since they can be easily inserted in the spine of a book, or along the back of a video cassette. The metal strip has special magnetic properties, making it saturate very easily in the presence of a magnetic field.

The detector device is characterized by large frames standing at either side of a doorway. Each of the frames contains a loop of many turns of wire. In fact the detector frames in the library near my home are of 'open' construction, so the size and shape of the coils can be clearly seen.

One loop of wire is strongly energized with AC, which is induced into the other loop standing parallel to it and perhaps a metre away. What we have so far, then, is a large air-cored transformer, and the receiving loop delivers a nice clean sine wave induced by transmitting loop nearby.

Now, if we introduce one of the metal strips into the field, it will saturate each time the field reverses polarity, introducing a spike onto the sine wave received on the second loop. The spike will be mostly harmonics of the original frequency.

All we have to do, then, is filter out the original sinewave frequency and measure what's left. When no strip is in the field, there should be no output from the filter connected to the second coil. But when the strip enters the field, causing spikes and thus harmonics, frequencies not removed by the filter produce an output which can be easily measured. Result: an alarm — somebody's pinching a book!

When you go through the library checkout procedure, each book has its spine 'swiped' along a de-activating device which then lets you carry the book through the detector without causing an alarm. It's been determined experimentally that if the magnetic strip is hit with a strong DC field from a permanent magnet, the strip itself becomes magnetized and is thus magnetically saturated. In that condition it can't saturate any more under the influence of the AC field from the loop at the library door. No saturation means no spikes, no harmonics, and no alarm. So the deactivating device is probably nothing more than a big permanent magnet.

Upon return of the book to the library, it is a simple matter to run it through a degaussing coil, removing its residual magnetism. Then it's all primed and ready to set off the alarm again, if someone carries it out the door without first checking it out.

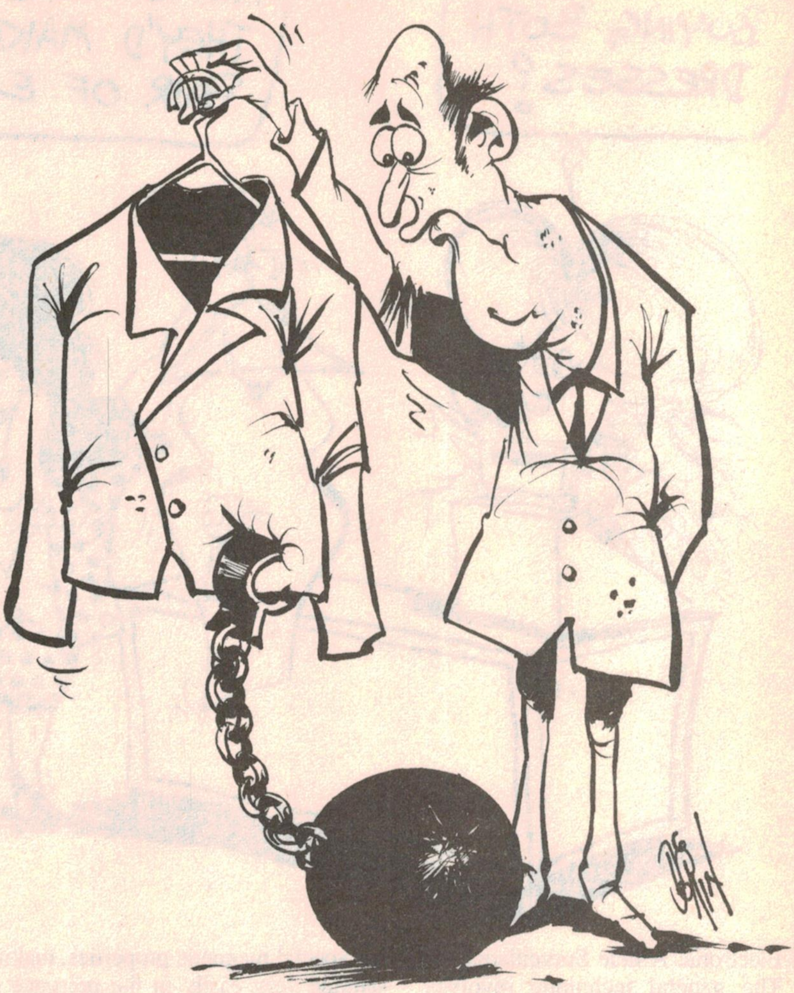
There is some concern about use of this system with video cassettes, because the magnetic fields are quite strong and it's

possible the tape itself will be affected by carrying it through the strong AC field at the door. 'Swiping' the cassette to deactivate it would also subject it to a strong permanent magnetic field.

In snooping through the video shops near my home, I didn't find one that was using EAS, at least of the magnetic strip type. Their method of shoplifting protection is much more direct: The video cassette boxes on display, the ones you pick up and examine, do not contain tapes at all. They are either empty or they contain styrofoam blocks. The tapes themselves are stored behind the counter, and they're handed to you only as part of the checkout procedure.

A variation on the magnetic system is based on a metal strip that is strongly resonant around 60kHz. Here a coil is also used to produce a magnetic field at 60kHz. But this time the field is quickly pulsed on and off. If the resonant metal strip is present within the field, it will keep 'ringing' briefly after the field is cut off. All the system has to do then is check for 60kHz energy being emitted after the energizing source is removed.

In theory it should be possible to do this with one coil and some quick transmit-receive switching, in a similar manner to something like a depth sounder that pulses and then listens for a return echo. Such a coil could then be mounted somewhere like under a floormat, invisible to a potential thief.



The very sharp resonance of this kind of strip is destroyed if the strip is magnetized, so deactivating it is again a matter of 'swiping' it along a permanent magnet. A degaussing coil can later be used to re-arm it.

UHF techniques

We've all seen those small white or beige tags that are attached to store goods such as items of clothing. You carry your purchase to the checkout, and when you pay your money, the operator uses a special tool to remove the tag. You're then free to exit with your new purchase. Should you neglect to have the tag removed, you'll suffer the same indignity as the old lady in the variety store as you carry the goods out the door.

This is quite a popular system, because it's very difficult to carry a tag out of the store without setting off an alarm. And it's almost impossible to remove the tag without the special tool — unless you're prepared to rip it off, damaging the item it's attached to.

The technology behind UHF tags is simple and elegant. The detector at the door consists of two parts, a transmitter and a receiver. The transmitter emits a continuous signal at around 900MHz and the receiver is listening on the second harmonic at 1800MHz.

Within the tag is a simple antenna, probably a folded dipole, with a diode connected across its terminals. When the tag enters the transmitter's field, the antenna receives the 900MHz signal and presents it to the diode, which acts as a **frequency doubler**. The same antenna then re-radiates energy at 1800MHz, which is detected by the receiver. Result — an alarm.

Due to the high frequencies involved, these UHF systems are very resistant to false alarms, except when certain old ladies pass through. A disadvantage is that the tags are moderately expensive, because a fairly high-quality diode is required to efficiently generate energy at 1800MHz. But since these tags are removed and used over and over, price is really no problem.

One fault with the tags is the damage they can cause to clothing. Although small, the tags do have some weight, and they are attached to the garment by a pin about the diameter of a small nail. Once I bought a couple of tee shirts at the above-mentioned variety store; they'd spent some time on display hanging on racks.

When I got them home I discovered that the cloth had been badly deformed by the weight of the tags, and each shirt sported a hole several times the diameter of the attachment pin. The hole had simply been pulled larger and larger. The shirts were only worth about five dollars each; perhaps it was a bit of overkill to protect such shoddy merchandise with these high-tech security tags.

There is another type of tag which can get by with a cheaper diode, and is thus considered disposable. It's much the same arrangement: an antenna with the diode at its terminals. The detector's transmitter is again operating around 900MHz, but this time there is another signal source at 100kHz.

When no tag is in the detector area the two signals happily exist side by side, with no interference between them. But when a tag is introduced, both signals hit the diode, which *modulates* the 900MHz sig-

nal with the 100kHz signal, and then reradiates it. To detect the tag, then, this system uses a receiver looking for a 900MHz signal with 100kHz modulation.

Since these tags are considered disposable, customers can legally carry them out of the store. So, to prevent an alarm, it is necessary to deactivate the tag once the purchase has been paid for. Given the crummy nature of the diode, the most likely way of deactivation would be to simply blow the diode — either by hitting it with a strong RF field or maybe with DC connected directly to the antenna.

A weakness of this kind of tag is that it can be accidentally damaged by static electricity. This gives credence to the theory of deactivating the tags by intentionally blowing their diodes.

Swept-HF tag

This is a special type of tag that appears to be new on the scene. The tag contains an inductor/capacitor circuit which is sharply resonant at around 8.7MHz. The detector unit again consists of two coils mounted each side of a shop doorway. The transmitter generates an 8.7MHz field, which is swept about 300kHz each side of centre. With no tag present, the receiver coil simply reproduces what the transmit coil is sending. But when the tag is introduced, the high-Q resonant circuit perturbs the signal in a manner which can be easily detected. Experiment has shown that *any* L-C circuit resonant at 8.7MHz will set off an alarm if carried through one of these detectors.

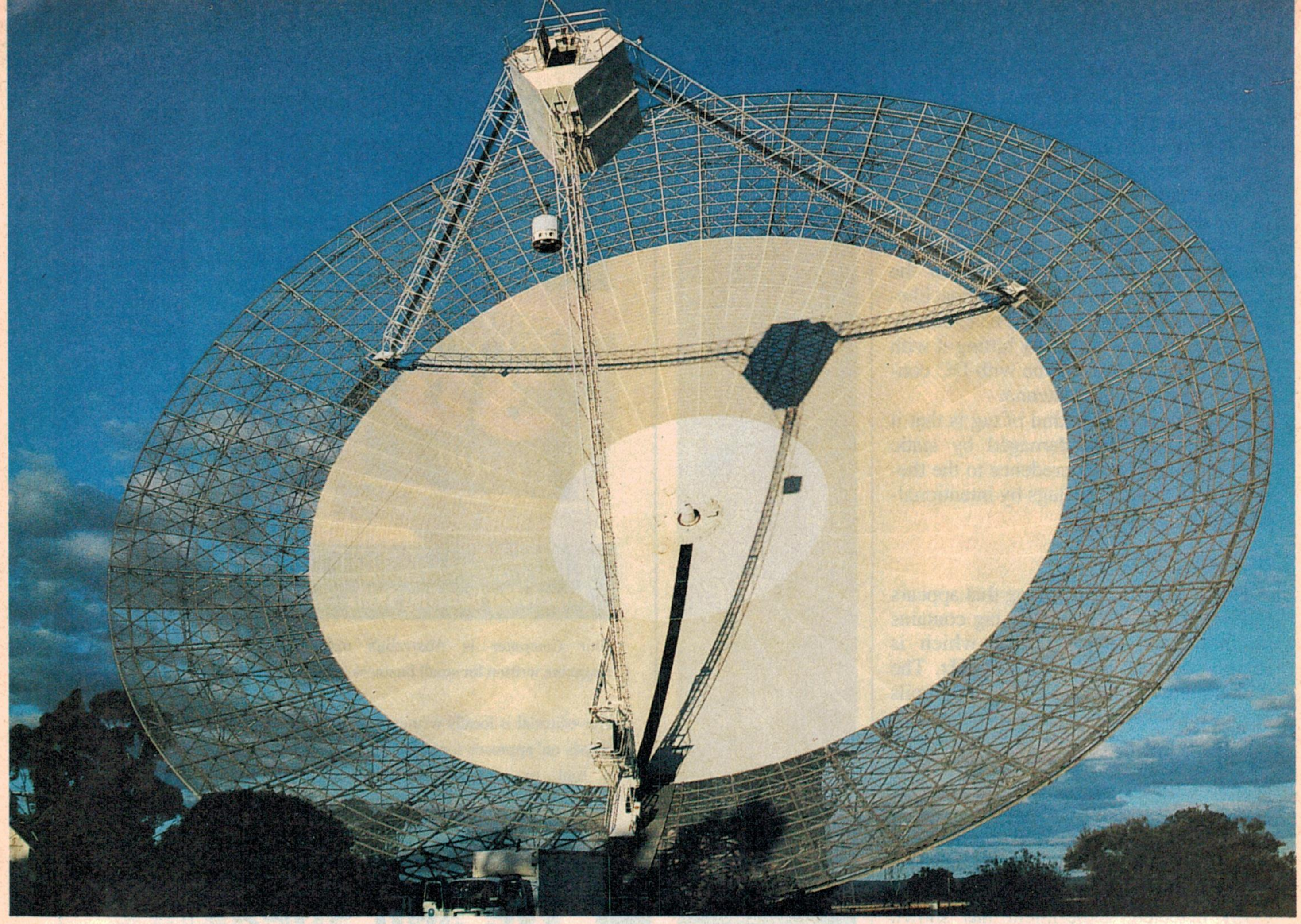
Don't try it

As mentioned previously, this information has come from sources of dubious repute. People who have experimented with cracking these systems may now be spending their days working on ways to defeat jail security systems. So our final advice is: read this, enjoy it and learn something; but DO NOT TRY USING THIS KNOWLEDGE to attempt breaking the law!

What we haven't done yet is solve the mystery of the old lady. It looks like, from the appearance of both the tags and the detector at the door, that the variety store is using a UHF system of the frequency-doubling type. So what's causing the false alarms? Maybe we've got a non-linear old lady...

Then again, there is one possibility that nobody's yet mentioned: Maybe she IS pinching stuff, carrying the tags through the door, and yelling "lawsuit" every time the alarm goes off.

Wouldn't it be funny if all this fancy technology could be simply defeated by bellows of indignation? ❖



GIVING PARKES A BETTER 'VIEW'

After having been upgraded with an enlarged focus cabin and 'translator', as described in our April issue, the Parkes Radio Telescope is now being fitted with a new Multibeam Receiver. This gives the telescope the ability to 'image' an array of 13 adjacent focal points at once. In addition each of the receiver's 13 channels produces two linearly polarised outputs, and all 26 of the resulting outputs can be analysed using an array of high-speed digital correlators, to detect up to 1000 different frequencies simultaneously...

by GEOFF McNAMARA

Our sense of sight is something we too often take for granted. We're able to see thanks to a collection of millions of tiny light-sensitive cells in our eyes. It takes 10,000 cells in each eye just to read this issue of *Electronics Australia*. But imagine if you only had a single photo-sensitive cell: you would have to look at a single point on a page, remember the location and intensity of that point, and then move onto the next one, on and on, slowly building up a complete image of an individual letter. Once done, you would do the same for the next letter — as soon as you found it! — and eventually build up a word, a sentence, a story...

This may sound tedious, but it's exactly what radio astronomers have to do all the time. Most radio telescopes are equipped with a single feed that can only respond to a single point on the sky. In order to 'read' the radio sky, astronomers have to aim their telescopes, collect sufficient signal from that point, then move on to the next point. This is extremely inefficient, simply due to the time it takes to build up an image of an extended object at radio wavelengths.

This is all about to change at the Parkes radio telescope in western New South Wales. The telescope is being fitted with a 'Multibeam Receiver' which uses an array of feeds, enabling the tele-

Participating Institutions

The Parkes Multibeam Receiver is a joint project between scientists from the Australia Telescope National Facility, the CSIRO Division of Radiophysics, the University of Western Sydney, the University of Melbourne Mount Stromlo & Siding Spring Observatories, the University of Sydney and several overseas institutes.

scope to image an area of sky twice the size of the full Moon. While this is far short of the field of view of our eyes, it will mean tremendous improvements to the rate — and variety — of 'stories' astronomers will read in the heavens.

At the front end of the Multibeam Receiver is a collection of 13 feeds that sit in the focal plane of the 64-metre paraboloidal dish. A cluster of waveguides channel the signals collected by the feeds into an evacuated dewar via 13 waveguide windows.

Inside the dewar are the amplifiers. Two linear polarisation radio signals are extracted from each waveguide and fed straight into 26 very low-noise HEMT (high electron mobility transistor) amplifiers. These are cooled to 20 Kelvins (-253°C) to reduce noise. The signals are amplified further and converted to an intermediate frequency centred on 160MHz.

The 160MHz IF signals are brought downstairs into the control room via 26 low-loss coaxial cables, and fed into a bank of electronics called the 'correlator'. The correlator is the heart of the system, and will enable the astronomers to map the nearby Universe. By dispersing the incoming radio signals into a spectrum, astronomers can identify radio emissions from specific sources and processes.

"In our case, we want to look at the 21cm line of neutral hydrogen", said Lister Staveley-Smith, Project Scientist for the Multibeam Receiver. The 21cm line allows astronomers to study the distribution and relative velocity of neutral hydrogen in the Milky Way and other galaxies. "The 21cm line is fairly weak and requires a large telescope", Staveley-Smith continued. "What we get from this line is not just where the source is located, but what the frequency of emission is," he said.

Due to the Doppler effect, the 21cm line emitted from a galaxy moving away from us will have moved to a lower frequency. Just where on the radio dial the astronomers find the 21cm line tells them how fast the galaxy is receding. Thanks to a well-known astronomical phenomenon described in 'Hubble's law', the astronomers can use the recession velocity to work out the distance to the galaxy. "So the velocity is very important in determining the three-dimensional structure of the nearby Universe", explains Staveley-Smith.

The problem is that when astronomers are using the telescope, they have no idea where on the radio dial they'll find the 21cm line for the galaxies they'll discover. "Unlike a conventional spectrum analyser, we have to receive all frequencies at all times, otherwise we're just throwing away signal", Staveley-Smith pointed out. "We can't just sweep through the spectrum as most spectrum analyzers do."

In order to search the radio spectrum continuously, each of the 26 signals coming down the line has to be divided into about a thousand different channels. "To do that we need a spectrometer, which in our case is a very fast digital correlator", Staveley-Smith said.

Correlators are very expensive electronic devices and have been one of the main reasons why multibeam systems are so rare. For example, the correlator used on the Australia Telescope Compact Array at Narrabri cost $1.5 million and only has about a third the capacity needed by the current project.

The new Multibeam Receiver module is winched up to the enlarged focus cabin of the Parkes radiotelescope. The array of 13 feed horns is visible at the bottom. (Picture courtesy Elly Hakvoort, ATNF)

Giving Parkes a Better 'View'

But things changed when NASA designed a new correlator chip as part of a major up-grade of the 300-metre Arecibo radio telescope in Puerto Rico.

The new chips were manufactured by Hewlett-Packard and cost a few hundred dollars each — a fraction of what they cost 10 years ago. Even so, the Australian team were lucky, as Staveley-Smith explained: "You place an order for these chips straight from the production run in the factory and you have to take what you get. There's a risk in what the production efficiency is: sometimes it can be a few percent; other times they can get it just right. In our case we ended up with 400 of these things!" The astronomers intend to use the extra chips on multibeam systems that operate at higher frequencies.

A thousand channels for each polarisation from each feed creates an enormous amount of data, but Staveley-Smith points out that the system will do more than simply collect the data. It will analyse it for you, too: "Unlike a lot of astronomy, we hope to produce maps of the radio sky in real time using some new hardware and software that we've installed at Parkes."

The ultimate aim, of course, is to create images of the sky at wavelengths that haven't yet been adequately explored. "A special region of interest in the southern sky is the galactic plane", said Staveley-Smith.

Because we're situated in the plane of our disk-shaped Galaxy, it's easier to see 'above' and 'below' the disk than through the plane. "In the optical and even the infrared it's not possible to see through the plane of the Galaxy because there's too much obscuring dust in the way. It turns out that there are some very interesting structures that are being obscured from our view."

One such object is known as the 'Great Attractor', so called because everything in the local Universe seems to be pulled towards it — whatever it is. "We hope to use the fact that the 21cm line can pierce straight through this gas and dust to make a much more detailed map of this particular region", Staveley-Smith explained.

But this is just the beginning. Already other radio astronomers are beginning to see just how useful the Multibeam Receiver will be. One enthusiastic group are the pulsar astronomers. As other observations are made, astronomers can use the same data to search for these spinning radio stars (see *Electronics Australia* March 1995). "That really adds to the scientific value, when one piece of astronomy can be piggy-backed onto another", Staveley-Smith points out. "Not only are we getting 13 times as much information from the telescope, but we're actually doubling that again by having two observations going on simultaneously. That's quite exciting in its own right!"

The new Multibeam Receiver is set to give the Parkes radio telescope — and the astronomers who use her — a new view on the Universe. It is scheduled to begin routine observations by late 1996.

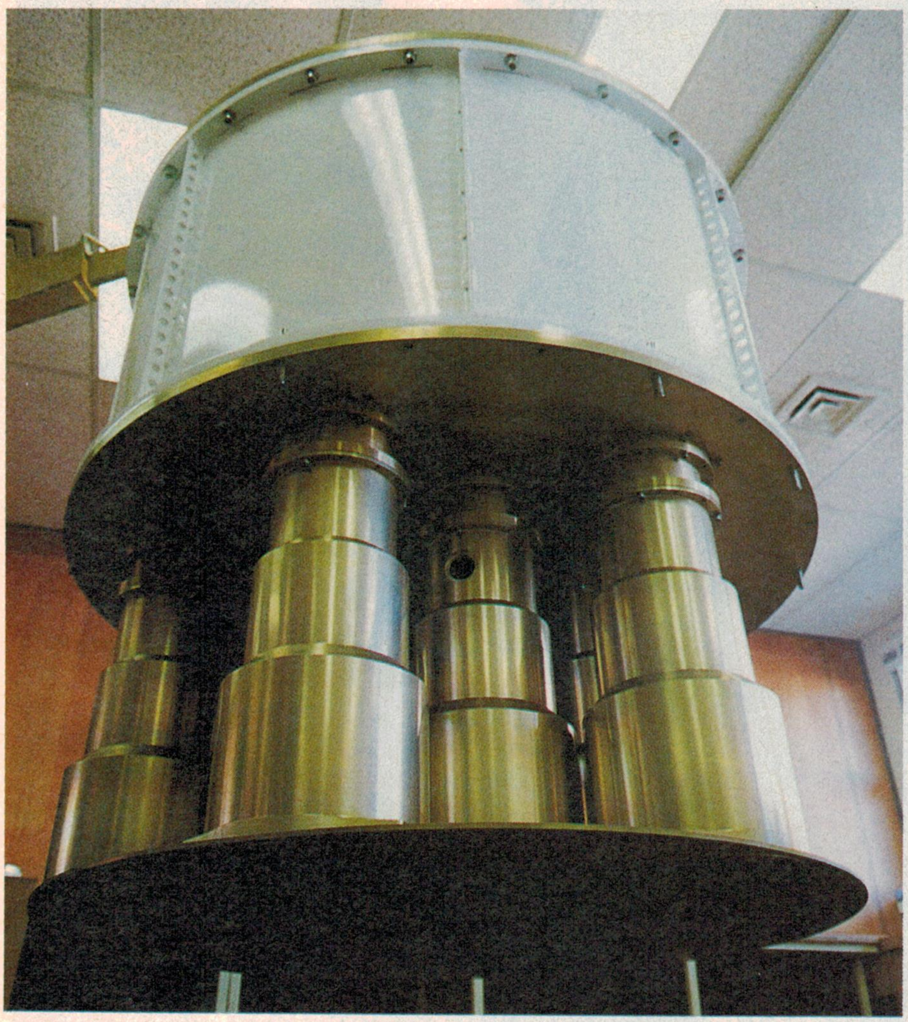
BIOGRAPHICAL NOTE: Geoff McNamara is a freelance astronomy writer who contributes to several Australian and overseas science and technology magazines. ❖

Taking its place on the Translator...

The Parkes Multibeam Receiver will be mounted on the new 'translator', which was part of the upgrade for the venerable Parkes radio telescope (see EA April 1996 issue, page 16).

Despite keeping the size of the dewar to a minimum, weight has still been a problem. "We were going to build the whole assembly out of stainless steel", commented Staveley-Smith. "This is a good material to use for strength and for holding vacuums."

Faced with a 400kg weight limit, however, the scientists had to look for an alternative material to build the 1.2-metre diameter dewar: "We had to redesign the dewar in aluminium, which is much lighter but not as strong, and very difficult to weld in such a way that it holds a vacuum", he added.



A closeup view of the Multibeam Receiver module as it was being assembled. Visible at the bottom are some of the 13 feed horns, with the dewar vessel at top. This houses the receiver's 26 low-noise HEMT amplifier/downconverters, operating at 21cm — about 1430MHz.

A SHORT HISTORY OF EARLY RADAR - 3

In this third article of our three-part series, the author summarises the efforts of British and US researchers in developing radar systems which were to help their forces to win World War II. To conclude the series he also reviews some of the more important developments in post-war years.

by JOHN BELL, B.E., M.Eng., F.I.E.E., F.I.E.Aust

During the wartime years 1939-45, it would be fair to say that radar development was closely allied to the thrust and counter-thrust associated with airborne operations over Europe and in the Battle of the Atlantic. Initially it was primarily a technical battle between the Germans and the British, later to be joined by the Americans.

Whether in peace or war, aircraft need to be detected and tracked and so range, bearing, numbers and aircraft speed and other data such as height and identification need to be made available. Simply put, one ideally needs a long-range surveillance system to be able to detect aircraft or other platforms, and then a corresponding system capable of tracking target(s) accurately so that engagement can occur.

Furthermore, if the target is a cooperative friendly or civil aircraft it will normally assist radar interrogation by responding to received signals — or alternatively, if hostile, only the reflected echoes from the transmitter would be received back on the ground. Thus at the risk of oversimplifying matters, we can group radars into surveillance or tracking, and active or passive types.

The British approach

These were some of the problems that the UK Tizard Committee needed to address back in the 1930s, along with the recognition that radar could be used for many other purposes including the detection of ships and submarines, on-board navigation, the identification of friend or foe (IFF), gun-laying, the control of air space and so on. Air and ship-borne systems were also required. The British policy was to design complete systems and integrate operations, a simple step not followed to the same extent by other powers — whose efforts and hence operational success were often more limited.

The success of the Daventry experiment (Ref.1) in February 1935 (see first article) and fear of German bomber raids led the British, under the guidance of Robert Watson-Watt (both Watson-Watt and Tizard were subsequently knighted), to establish a number of ground-based radar Chain Home stations along their southern and eastern coasts as early as 1937. By 1939, this system, which initially operated at between 22 and 30MHz using elementary pulse techniques, was capable of detecting hostile aircraft at a range of 200km and was to play a significant role in the Battle of Britain.

Initially the first stations were situated near to London, but by 1939 they ran right along the South Coast up to Northern Scotland. These initial Chain Home (CH) stations had wide azimuth beamwidths with limited vertical coverage, and were successfully used to detect all but low-flying aircraft.

A later, but complementary development to address this problem of detecting low flying aircraft was to be the introduction of Chain Home Low Flying (CHL) stations, which operated at about 200MHz and which used elementary azimuth beam steering techniques in early 1940.

The subsequent marriage of long-range aircraft detection with height, direction and range resulted in the availability of the hugely successful and very similar Ground Control Intercept (GCI) stations, which were to be particularly useful for directing night fighters equipped with Airborne Intercept (AI) radar. The techniques of ranging and beam-steering were also to be applied to coastal gunnery, the location of mine-laying aircraft and the detection of U-boats.

Naturally, most of this work in developing radar systems was carried out under the cloak of secrecy, with Germany and Britain in particular carrying out clandestine measures to determine what the other side was up to. Today this is called ELINT (Electronic Intelligence). Germany's Graf Zeppelin was flown up the English Channel in order to try to get the British to switch their Chain Home system on, so the Germans could monitor received signals, hence deducing how the British system worked!

The disclosure of information was minimal, even among friends, though the US and British were to start major cooperative programs early in the war.

The British had one great advantage when war eventually came, and that was

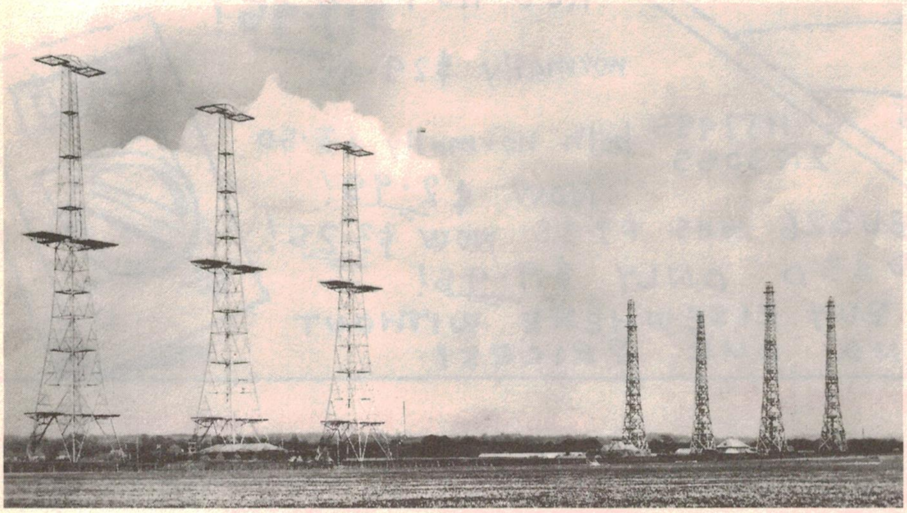


Fig.3.1: Chain Home (CH) antennas situated on the British East coast. The 360ft steel transmitter towers are on the left, the 240ft receiver towers on the right. (Courtesy GEC-Marconi).

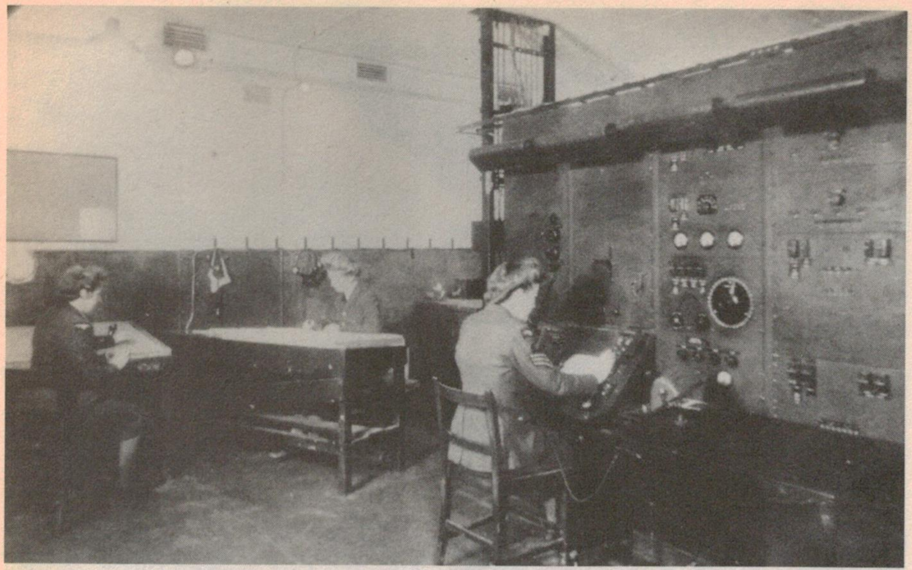


Fig.3.2: WAAF operators operating CH receiver equipment. Note the radiogoniometer (large circular dial), which was used to determine the direction of a target by observing variations in signal strength as the radiogoniometer coil was rotated. (Courtesy GEC-Marconi)

they had an integrated command and control system to complement their Chain Home Stations. This allowed them to use the data received to guide their fighters to intercept the incoming bomber streams. A second, and lesser known, advantage was that the British were first in the field of applying a new science of Operations Research to resolving problems associated with the application of the new technology to Service needs.

Some more important British developments will now be discussed, commencing with airborne systems.

Navigation and H2S

At any time map reading for aircraft navigators is difficult, except on clear moonlit nights. This was made even more difficult for RAF navigators, who had often to contend with 8/10 cloud when under attack from ground defences. It was quite common for bombers to lose their way, ending up bombing the wrong targets or failing to return to their base.

To help combat this navigation problem a scanning system called H2S was developed, which allowed a rough plan of the ground below an aircraft to be displayed. The initial system operated at S-band (10cm) but later versions, operating at different wavelengths including X-band (3cm), with much improved display facilities were soon in operation. These allowed the navigators to identify major ground features.

However the introduction of this system not only alerted German defences to an imminent raid but allowed German night fighters equipped with 'Naxos' to home in onto individual bombers. Thus H2S became a device which needed to be used sparingly if it were not to become a liability.

The other problem was that H2S used a magnetron, and as the magnetron is virtually indestructible, the British were well founded in their fears — soon to be confirmed — that a magnetron would soon fall into German hands. Because H2S was a mapping device, it was extremely useful in detecting surface vessels or U-boats which had surfaced in order to transmit or recharge their batteries.

(The acronym H2S is said to have been coined from the use of the Theorem of Pythagoras, where H is the height squared and S the square of the slant range. Aircrew called it 'Home sweet home!')

British efforts had also resulted in the development of ASV (aircraft-to-surface-vessel) radar, which was used successfully during the war to allow reliable rendezvous with convoys, the detection of ships and submarines and as a navigation aid. These PPI mapping systems operated in the VHF band and were the workhorse of Coastal Command, especially as weather conditions were frequently atrocious. They were capable of detecting a surfaced submarine at 10km and landfall at 65km.

By 1942 the U-boats were able to detect the presence of ASV VHF transmissions and it was found necessary to adopt the Mark 3 version, essentially a modified H2S which operated at frequencies the U-boat receivers could not detect. Together with the development of well organised direction finding (D/F) techniques aimed at U-boats and other vessels breaking their high frequency communications silence, life became ever more difficult for the German naval personnel: radar, D/F and Asdic became a deadly combination.

Bombing with Oboe

Another system developed by the British was Oboe, which turned out to be the most precise bombing system of the war. Two well-separated ground stations emitted pulses which were picked up by a special airborne receiver, so defining aircraft range from each ground station. The aircraft's position and bomb-aiming point were therefore simply defined, for here is the classic school geometry triangle with three known sides, no angles being involved. (Actually the aircraft would need to fly an arc with respect to one of the stations to emulate the school student using a pair of compasses.)

On the ground and at sea, quite sophisticated fire-control radars were being developed such as the Anti-Aircraft No3, Mark

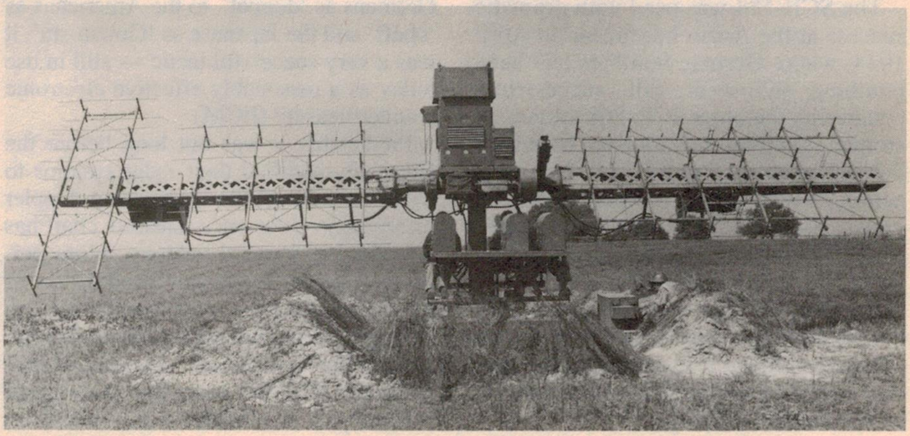


Fig.3.3: SCR-268 radar equipment of the 496th Anti-Aircraft Artillery Battalion shown in the field during 1943. These operated at about 200MHz. The Germans countered them using their airborne Kettenhund and Karl ground jammers. (Photo courtesy US National Archives)

III mobile fire-control radar which operated at about 204MHz. By this time the radar control of servomechanism systems were resulting in the automatic tracking and engagement of targets.

The US approach

In the USA, both the Army and Navy developed separate VHF/UHF pulse radar systems which were operational by 1940.

Prior to the outbreak of war the Army had tested the SCR-268 pulse radar operating at 205MHz, which was capable of detecting aircraft at 40km; later versions were mainly used for searchlight control. From this followed the mobile SCR-270 and fixed station SCR-271 systems, which both operated at 106MHz, with aircraft detection range now being up to 200km. Later the US Army Air Force were to remodel the British air-to-surface 176MHz (ASV) MkII Radar to the SCR-521, and the 200MHz Airborne Intercept (AI) Mark IV Radar to the SCR-540.

Following a visit of the so-called Tizard mission in September 1940, when the British handed over details of the newly-developed cavity magnetron, it was agreed that the newly formed Massachusetts Institute of Technology Radiation Laboratory would undertake the development of radar systems in the microwave bands. Much of this work was recorded for posterity (Ref.2), and was to lead to the production of Aircraft Intercept and long-range navigational radars as well as precision gun-laying systems.

The SCR-720 Airborne Intercept radar operating in S-band (3GHz) for night fighter use, and the Eagle AN/APQ-7 high resolution ground-mapping X-band (9.3GHz) radar for high altitude blind bombing were developed. The SCR-584 was possibly the first really mass-produced successful gun laying radar used; it operated in S-band.

The SCR-584 was used with dramatic success at the Anzio beachhead in April 1944, where German bombers had been bombing almost at will, successfully countering the older SCR-268 system by simple jamming techniques, including the dropping of 'chaff'. In their first action, which was at night, some 48 guns, controlled by hastily installed SCR-584 (and SCR-545) radar dropped five out of 12 Junkers 88's in their first salvo (Ref.3). The rest jettisoned their bombs and fled. This simple action went a long way towards establishing the success of the beachhead and helped shorten the Italian campaign.

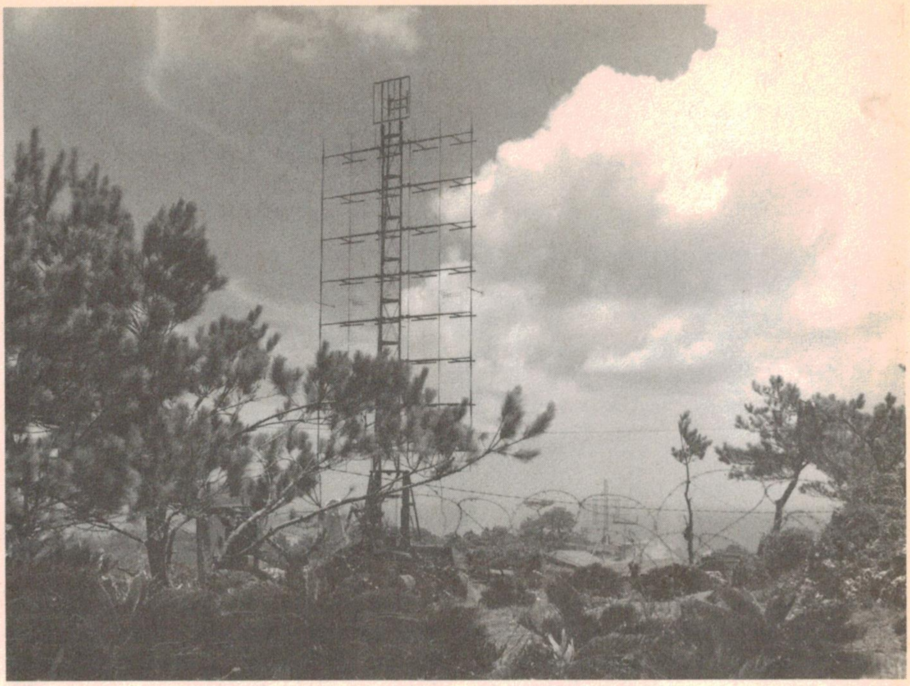


Fig.3.4: SCR-270 early radar warning equipment of the 2nd AAA Battalion in position at Point Bolo, Okinawa in 1945. These operated at about 100MHz and were susceptible to jamming. (Photo courtesy US National Archives)

Electronic warfare

To counter the threats posed by radar, aircraft navigation and other detection systems, a battle of wits then developed — leading to what is today known as Electronic Warfare (EW). Frequencies were changed, powerful noise and deception jammers were sited on the ground and in aircraft in order to try to obliterate the enemy's signals.

More adroitly, the enemy's signals could sometimes be interfered with to give misleading information. In 1943 the British started to protect their bombers by dropping large quantities of aluminium foil in front of their bomber streams: this foil was cut to one-half of the German radar's wavelength and simply reflected back the transmitted signal(s), so obliterating the entire bomber force from view. Known to the British as 'window', to the Germans as 'duppel', to the Americans as 'chaff' and the Japanese as 'Giman-shi', it was a very successful tactic — still in use today as a reasonably effective electronic countermeasure (ECM).

Predictably it was not long before the Germans modified their radar systems to try to see through the chaff, using doppler information — as once released, chaff has no effective forward velocity. More precisely Doppler frequency modulation of the returned carrier wave can be used to distinguish between static and moving targets. Thus electronic counter-counter measures (ECCM) were introduced, and became part of a further battle of wits as each side tried to outdo the other in turn. (It is as well to remark that these aspects of EW contributed in the long-term towards making today's commercial radar systems more reliable, in that they could less easily be interfered with, whether by the weather, intent or by accident.)

Post-war developments

The cessation of hostilities in 1945 saw only a brief period of consolidation in radar development. Its use for peaceful purposes had long since been recognised, especially for air and sea traffic control, collision avoidance, weather mapping, navigation, surface mapping and the exploration of space, and these were soon to become important. Nevertheless it was not long before military type radars development restarted, for this was to be the onset of the present day era of radar guided weapons and countermeasures. And sadly other wars were to follow.

The cavity magnetron (with its essentially fixed frequency range) was complemented and often replaced by the higher power klystron and its derivations. Although the cavity magnetron is still used today, the klystron amplifier offers the advantages of parallel operation and complex modulation systems.

The wideband Travelling Wave Tube (TWT) amplifier became reality; this is still used in specialised military applications and microwave links. The introduction of the transistor saw reliability increased and equipment size

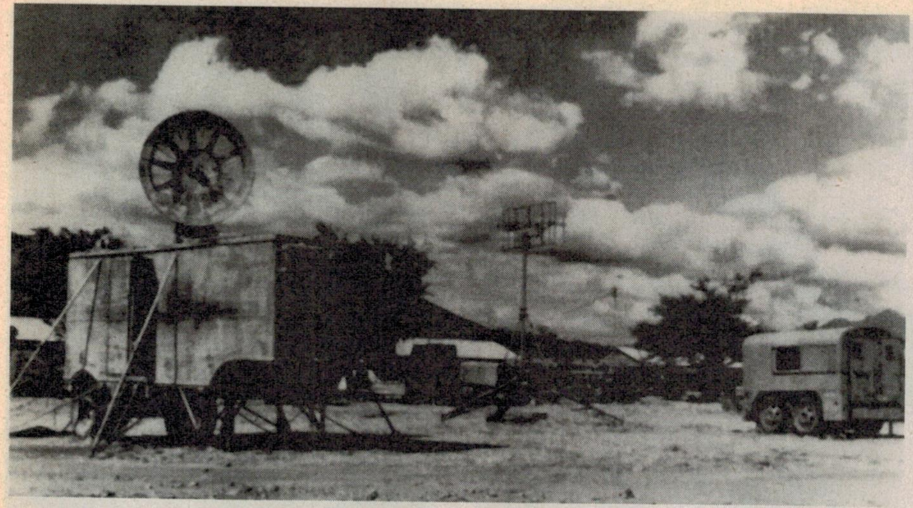


Fig.3.5: The SCR-584 microwave radar shown here was probably the first altogether successful gun-laying radar ever used in combat.

decreased. The fear of intercontinental ballistic missiles saw a renewed interest in developing special radars in the VHF and UHF bands, with their ability to perform reliable long-range detection in place of the line-of-sight microwave systems. Radar theory was also being developed and digital techniques were being used by the 1960s.

Probably the biggest advances during the past 25 years have been the impact of the use of the semiconductor as a low-noise front end amplifier for receivers, to replace the more cumbersome parametric and maser amplifiers; the electronically steered arrays; and, most of all, the impact of digital signal processing which has allowed a near-optimal extraction of information from the data received, and enhanced methods of presentation to the human observer. Matched filters also allow the use of pulse compression techniques, where relatively long modulated pulses may be transmitted, pulses which after receiver processing look to be of a high power short duration.

Despite all of these advances, there is still room for improvement. Interpretation of data is still very much a human activity and symbolic presentations are inferior to the real world which the human eye sees. Operationally, radars are now being used for remote sensing of the environment which, sensibly used, will assist in the assessment of earth's resources as well as in environmental control.

Radar guidance of missiles is now commonplace. Missiles can now be launched from land or sea to engage aircraft — the so-called SAMs (surface-to-air missiles). There are missiles which can be launched from ships to engage other navy ships, surface-to-surface navy missiles (SSNs), air-launched-to-surface (ASVs) and so on.

The advent of electronics, modern communications and radar have made modern warfare a complex business, very often controlled and fought away from the actual battle front. Probably the recent use of radar-based systems has avoided a repeat of the carnage associated with two World Wars. The experiences of the Gulf War indicate how deadly radar and similar guided weapons have become.

Today the radar originally conceived to deal with the perceived bomber threat is a vastly superior system. Commercial aircraft carry transponders which not only identify the aircraft (a throwback to the old IFF system), but relay height information as well and which coupled with doppler navigation, terrain mapping and weather warning makes air travel exceptionally safe.

Safety at sea has been enhanced by collision avoidance and navigation radars. And dare I say it, but the use of Doppler radars by the police have surely lessened our dreadful road toll.

Not all developments or systems can be covered in three articles such as this. For readers whose appetite has been whetted, the following bibliography contains much useful and interesting reading.

It is unfortunate that major technical and scientific advances are often made or accelerated due to a threat of, or because of, war. Radar is no exception and nor, for that matter, is medicine. Despite this the author feels that the development of radar has been for the benefit of mankind and hopefully, will help to establish lasting peace, increased safety on land, at sea and in the air and lastly, the sensible use of our planet's resources.

Acknowledgements

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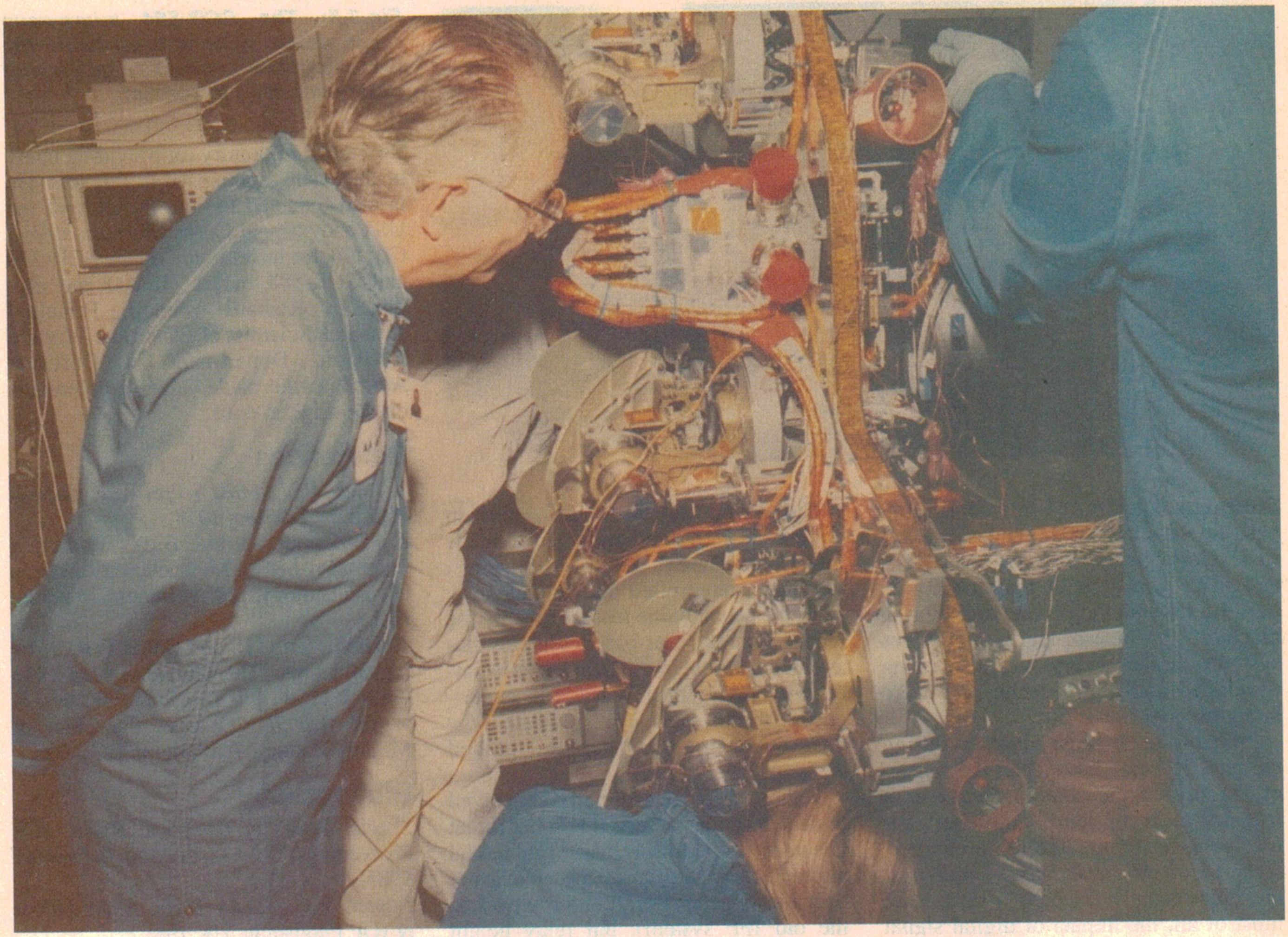


IRIDIUM ON TRACK FOR LAUNCH IN 1998

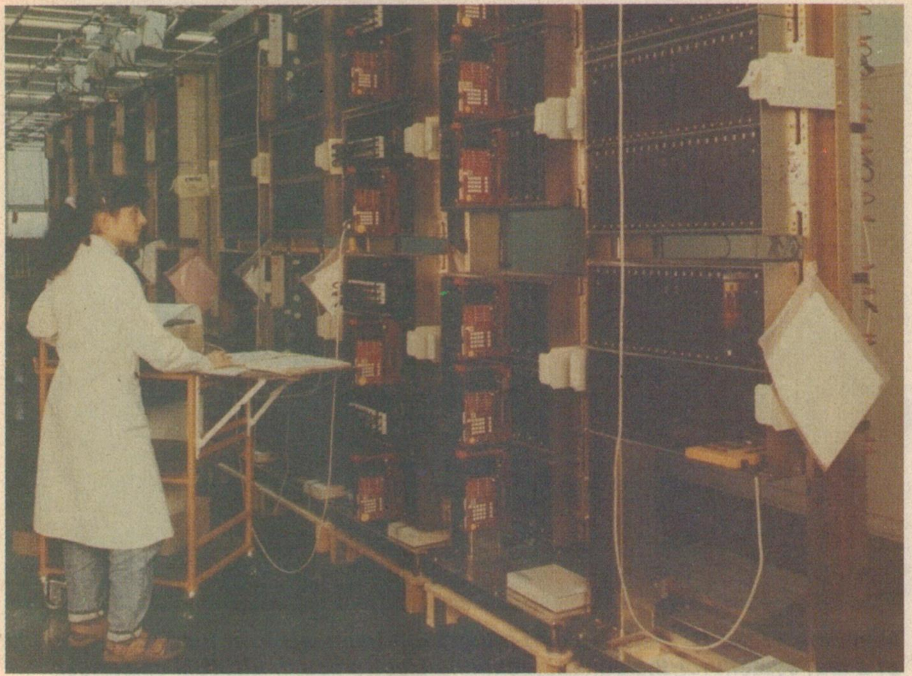
Many *EA* readers will have heard of IRIDIUM, the global telecommunications system being built by a world-wide consortium of major telecomm firms. Planned to begin operation in 1998, it will employ an array of no less than 66 low-orbit satellites to deliver voice, data, fax and paging services to hand-held telephones virtually anywhere on the earth's surface. Here's an up-to-date report on how this massive project is progressing.

by PRAKASH NADKARNI (Technical Director Marketing, Iridium, Inc.)
and JOHN WINDOLPH (Director of Corporation Communications, Iridium, Inc.)

The IRIDIUM system is a satellite-based, wireless personal communications network that is designed to permit any type of telephone transmission — voice, data, fax, or paging — to reach its destination anywhere on Earth. Consisting of 66 interconnected satellites orbiting 780km above the Earth, the IRIDIUM system will facilitate communication for business professionals, travellers, residents of rural or undeveloped areas, disaster relief teams, and others. As the launch date of the first IRIDIUM satellite approaches, the many various elements of the program remain on, or ahead of, schedule to deliver global wireless personal communications in 1998.

Launch schedule

The first IRIDIUM satellite is scheduled for launch later this year. Three locations will serve as launch sites: Vandenberg Air Force Base, near Lompoc, California, USA; Baikonur Cosmodrome in Kazakhstan in the former Soviet Union; and Taiyuan Satellite Launch Center, which is located 650km



Above: A Siemens EWSD - based D900 switch will perform the call processing for the IRIDIUM system.

Left: Technicians inspect the gateway and crosslink antennas of an IRIDIUM satellite.

How IRIDIUM began...

In 1987, Motorola engineer Bary Bertiger was on vacation in the Cayman Islands with his wife, a real estate agent who was frustrated because she didn't have easy access to a telephone. While relaxing on the beach, Bertiger decided that it should be possible to provide a global telephone system using satellites.

On his return, he and colleagues Raymond J. Leopold and Ken Peterson developed the idea of a satellite based system using low earth-orbit satellites. All three are generally credited as inventors of the IRIDIUM system.

The system was announced by Motorola in June 1990, and soon after Iridium Inc. was formed as a global consortium to develop and build the IRIDIUM system. Members of the consortium are Motorola Inc. (also the prime contractor); Raytheon Inc; Sprint Communications; Lockheed Martin Corporation; Vebacom AG; Pacific Electric Wire & Cable Co., Ltd; Societa Finanziaria Telefonica per Azioni (STET); Korea Mobile Telecom; Thai Satellite Telecommunications Co. Ltd; Khrunichev State Research and Production Space Center; Iridium Africa Corporation; Iridium Canada, Inc; Iridium China (Hong Kong) Ltd; Iridium India Telecom Ltd; Iridium Middle East Corporation; Iridium SudAmerica Corporation; and Nippon Iridium Corporation. Many of these members are themselves consortia of telecommunications and electronics firms in their respective countries.

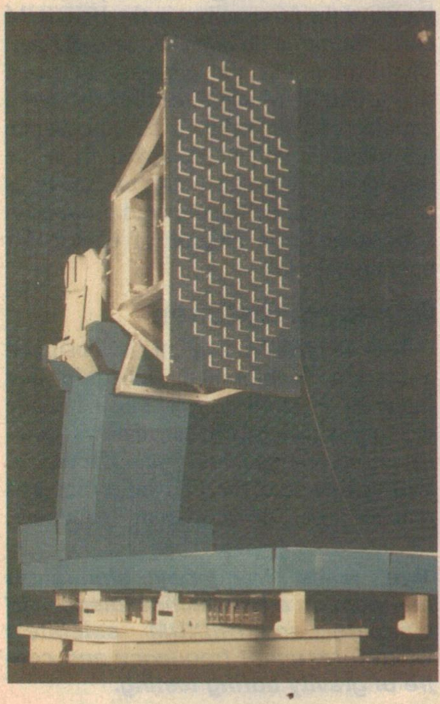
southwest of Beijing in China.

Earlier this year, the first of several Pathfinder exercises were conducted. These exercises are launch rehearsals that enable teams from the launch facility, Motorola, Lockheed Martin, and Iridium, Inc. to validate space vehicle launch procedures, timelines, and interfaces.

Preparations began many months prior to the launch exercises. Shipping as much as 27 tonnes of spacecraft and equipment to each of three launch sites presented considerable logistical challenges. Additional requirements were necessary for the Chinese and Kazakhstan launch sites, including obtaining authorisation to transport assembled spacecraft outside of the United States.

New US customs initiatives related to increasing export activity at the port of Phoenix, Arizona, USA, recently made it possible for IRIDIUM satellites to be inspected on-site at Motorola's Satellite Communications Division in Chandler, Arizona, USA. This new arrangement will preclude an unnecessary landing at a port of export, reducing potential damage to the satellite and streamlining the export process.

Prior to the Pathfinder exercises at Taiyuan Satellite Launch Center, the Long March 2C rocket had been transported from the China Academy of Launch Technology in Beijing. The launch exercises included dummy fueling, mating onto the dispenser, interface checks with the launch vehicle, and other launch processing activities. Engineering staff and technicians artended from both the China Academy of Launch Technology and China Satellite Launch and Tracking Control General.



An IRIDIUM satellite main mission antenna panel undergoes qualification testing at the Raytheon Electronics Systems plant in Waltham, Massachusetts.

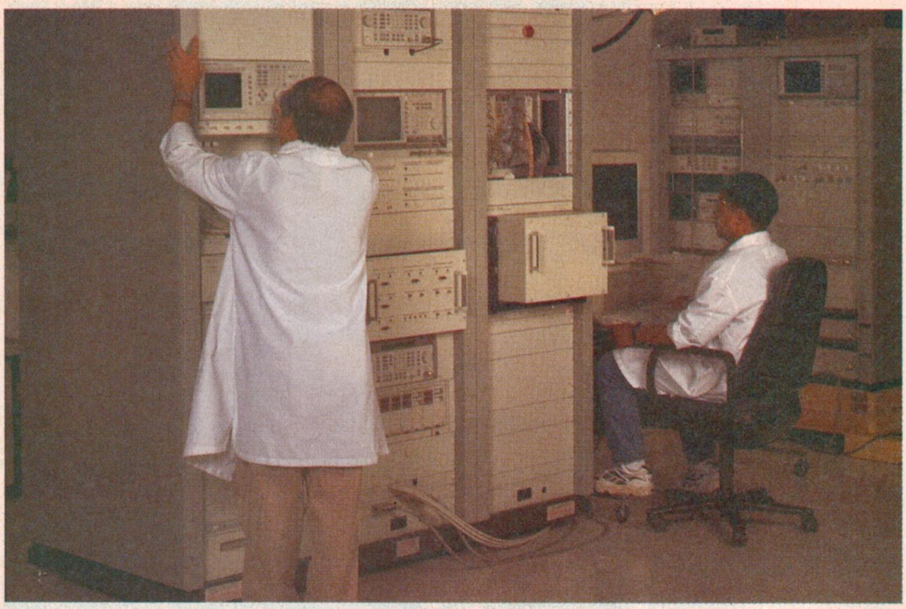
Last May Pathfinder exercises began at Vandenberg, where the first IRIDIUM satellites are scheduled to be launched. The three Delta II launch vehicles that will launch IRIDIUM satellites are now in final assembly in the Pueblo, Colorado, USA, facility of McDonnell Douglas. These rockets will be delivered to Cape Canaveral, Florida, USA, for checkout before being shipped to Vandenberg.

Vandenberg's SLC-2 launch complex, which is NASA property, has recently been refurbished, including the tower and blockhouse equipment. After the IRIDIUM structure test vehicle was unpacked for the Pathfinder exercises, it was mated with the McDonnell Douglas dispenser, which will simultaneously deploy five IRIDIUM satellites in space.

Thanks to a lighter fairing than was originally planned, the Delta II launch

vehicles will be able to deliver the IRIDIUM space vehicles to a higher insertion orbit. This improved capability will allow the IRIDIUM space vehicles launched on the Delta II to arrive on orbit with a larger amount of station-keeping fuel.

In addition to the 40 satellites it will launch as part of the original constellation, McDonnell Douglas announced last December that it had signed a contract with Motorola's Satellite Communications Division to launch 15 other satellites. The additional launches will be used in the IRIDIUM system's operations and maintenance phase. McDonnell Douglas will place the satellites into low-earth orbit using the 7420 model of its Delta II rocket. These five replenishment launches will each carry three satellites.



Members of the Hewlett-Packard integration team work on the final assembly of a test system for the communications electronics in IRIDIUM satellites.

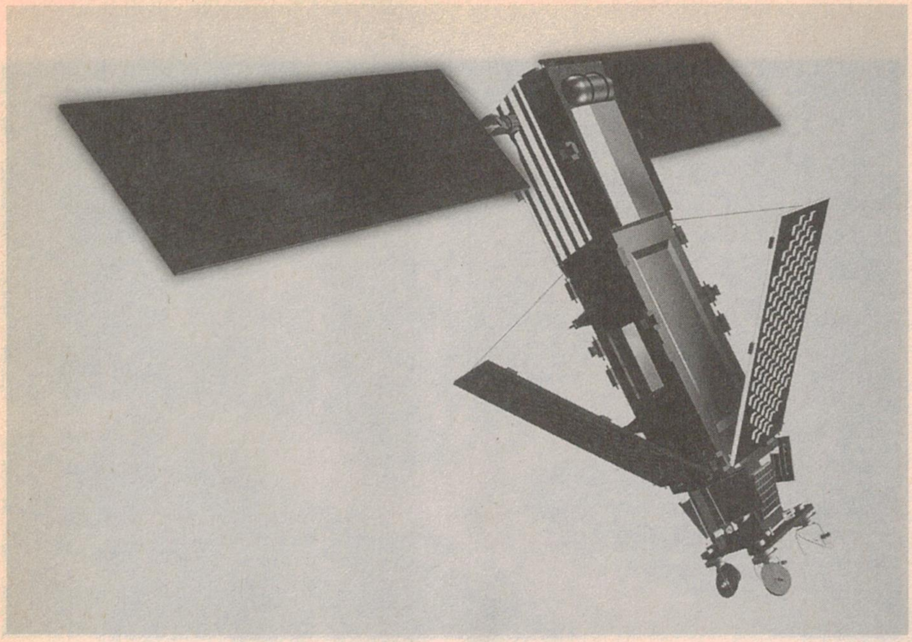
Next September, Pathfinder exercises are scheduled to take place at the Baikonur Cosmodrome in Kazakhstan in the former Soviet Union. Engineers at the Khrunichev State Research and Production Space Center, a state-owned aerospace engineering company in the Russian Federation, completed rail transport tests at the launch site last winter. These tests verified the process of moving the Proton rocket from the assembly building (where the IRIDIUM space vehicles and the rocket are mated) to the launch pad.

The Proton launch vehicle is the largest of the three rockets that the IRIDIUM system will be using. Current plans call for 21 of the 66 satellites in the IRIDIUM constellation to be launched at Baikonur. The Proton has the capacity to place seven IRIDIUM satellites directly into a circular transfer orbit at 512km, where the satellites will be deployed from the dispenser. From that point, the satellites will be moved by the onboard propulsion subsystem to an altitude of 650km for operational orbit.

Recent milestones

The IRIDIUM system is designed around a development schedule that includes 47 milestones. They include design reviews, readiness reviews, qualification testing, and manufacturing. Earlier this year the midway point was reached on development schedule.

Two mass frequency simulators mounted on a Khrunichev 'dispenser' simulate an IRIDIUM satellite's weight, resonant frequency and centre of gravity during testing.



At the top of each IRIDIUM satellite are two solar panels which supply power to the battery module at the top of the 'bus'. In the middle is the communications section, triangular in cross section, with three swing-out L band planar antennas which together provide a total of 48 spot beams for earth coverage. At the bottom are the Ka band cross-link and uplink/downlink antennas.

Several significant milestones are discussed below.

Assembly of the First Space Vehicle for Qualification Testing: A major stage in the IRIDIUM program involved qualification testing. The assembly of the first space vehicle for qualification testing involved integrating the satellite bus, main mission antenna, communications module, and related test software. A new welding method developed by Lockheed Martin significantly reduced the production time for assembling the space vehicles. The new method involves welding the interconnects between the solar cells that provide electricity aboard the spacecraft. In addition to creating a stronger bond, the new method reduces from two weeks to two days the time required to attach the solar cells.

Test and Development Readiness Review: Testing is a key component of the IRIDIUM system's development schedule and the Test and Development Readiness Review confirmed testing methods. Low-level tests were initially performed and the testing built progres-

Basic facts about IRIDIUM

Planned to begin operation in 1998, the IRIDIUM system is based on a constellation of 66 operational satellites in polar orbits at a height of around 780km above the earth. The satellites will be in six orbital planes, with 11 operational satellites and two on-orbit spares per plane.

Each satellite in the IRIDIUM system will communicate with handheld subscriber telephones using frequencies in the range 1616 - 1626MHz, in the L band. Upward and downward feeder links to IRIDIUM earth stations will use frequencies in the Ka-band ranges between 19.3 - 19.6GHz (downlinks) and 29.1 - 29.3GHz (uplinks). In addition the satellites in adjoining orbital planes will be cross-linked using frequencies in the Ka-band between 23.18 and 23.38GHz.

Each satellite will be solar powered, will weigh approximately 689kg and will have a design lifetime of 5 - 8 years. The satellites each have three main 'mission antenna' panels, which each support up to 16 spot beams — giving a continuous ground cover of 48 cells per satellite. Each antenna panel measures 1860 x 860mm x 40mm thick, and weighs only 38kg. The system is designed to achieve a 16dB 'link margin' with handheld phones using an antenna with a gain of only 3dB.

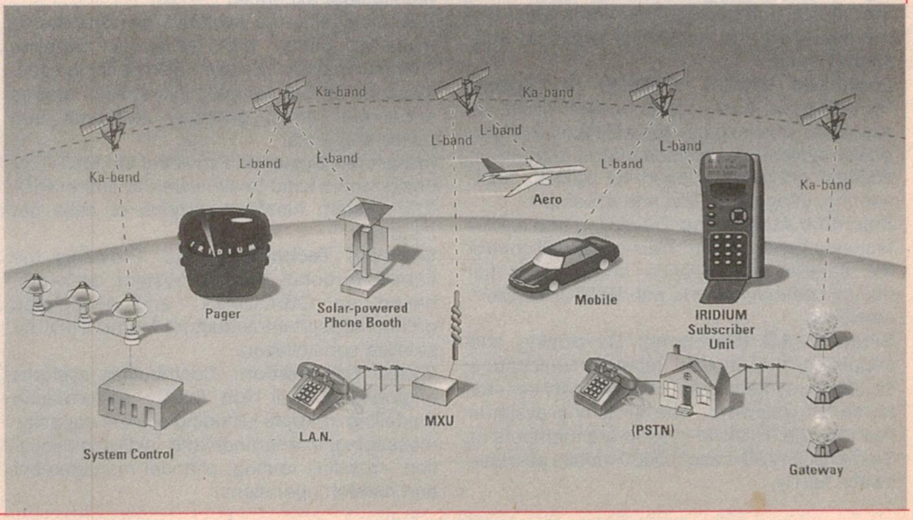
In addition to the main mission antennas, the satellites each have an array of smaller Ka-band antennas used for uplink and down communication as well as cross-linking between satellites.

Hand-held phones for use with the IRIDIUM system will be dual mode, and capable of communicating with either the orbiting satellites or a local terrestrial digital cellular system. They will use QPSK (quadrature phase-shift keying) digital modulation, with frequency division/time division multiple access (FDMA/TDMA) technology.

The first IRIDIUM satellites are being launched later this year. To achieve rapid deployment, the satellites will be hauled aloft in rockets carrying from two to seven satellites at once. Three separate launch sites are being used: Vandenburg Air Force Base in California, USA; Baikonur Cosmodrome in Kazakhstan, in the former Soviet Union; and Taiyuan Satellite Launch Centre in China.

The US launchings are being handled by McDonnell Douglas, which will launch a total of 40 satellites via Delta II rockets, each carrying five satellites. Those launched in Kazakhstan will be handled by Russia's Khrunichev State Research and Production Space Centre, via Proton rockets each carrying seven satellites. The launches from China will be aboard Long March 2C/2D rockets built by the China Great Wall Industry Corporation (CGWIC). Both the KSRPSC and the CGWIC are members of the IRIDIUM consortium.

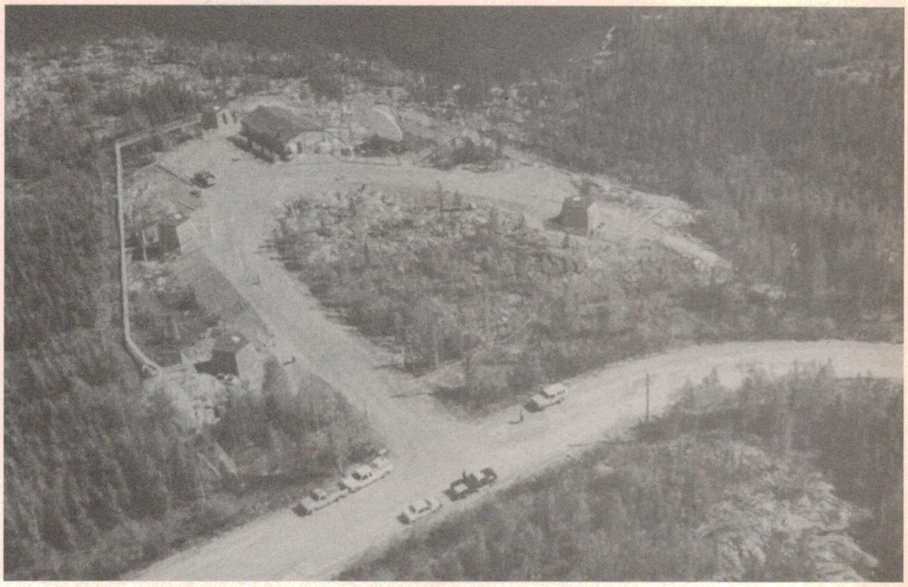
McDonnell Douglas has also won a contract to launch 15 additional satellites during the later maintenance phase.



sively to include more intricate features of the constellation. Testing the ground interface with the L-band link was one part of this readiness review.

Production Readiness Review: At peak production, IRIDIUM satellites will be manufactured at a rate of one per week. The Production Readiness Review confirmed that suppliers can provide a continuous flow of the various components required to manufacture the spacecraft flight hardware. An important part of this review involved evaluating the tooling and material supply line.

Space Vehicle Qualification Test: The IRIDIUM satellite's major components — the satellite bus module, communications module, and the main mission antenna — underwent a variety of qualification testing at Lockheed Martin Missiles and Space Headquarters in Sunnyvale, California, USA. Acoustic testing demonstrated the satellite's ability to withstand launch vibration. Pyrotechnical shock tests verified that the satellite can withstand deployment. Thermal balance testing assured the adequacy of the spacecraft thermal control systems in meeting the needs of the spacecraft in the on-orbit environment. Electromagnetic compatibility tests confirmed that the hardware subsystems will not interfere with each other.



The IRIDIUM telemetry, tracking and control facility (TTAC) in Yellowknife, Northwest Territories, Canada. It was built by Telesat Canada, which has also built similar TTAC facilities at Oahu in Hawaii and Iqaluit in northeastern Canada, and will be operating all three of these TTACs.

Space System Multi-Space Vehicle Tests: A distinguishing feature of the IRIDIUM system is its intersatellite links. The Space System Multi-Space Vehicle Tests demonstrated the ability of an individual subscriber unit to communicate with another individual subscriber unit by a path involving multiple space vehicles. The tests were performed in a simulated orbit environment with RF links and a Doppler shift simulator representing orbit conditions.

Satellite Control Facility and Telemetry, Tracking, and Control Integration and Tests: The Satellite Control Center at Motorola's Satellite Communication Division in Chandler, Arizona, USA, will soon be ready to support first launch operations. The Satellite Control Facility and Telemetry, Tracking, and Control Integrations and Tests verified that the Satellite Control Center, which will serve as the launch control center, works with the Telemetry, Tracking, and Control (TTAC) west facility. It also demonstrated that the satellite control software and hardware have been fully integrated and tested for functionality.

The firms building IRIDIUM

The list of companies and organisations currently involved in building the IRIDIUM system includes many of the major national and multinational players in telecommunications and electronics. Here's a summary of the main participants and their involvement:

Motorola Satellite Communications Division: The prime contractor, and also providing the communications payload aboard each satellite — including the digital network switching, cross-satellite connectivity and the satellite processors.

Raytheon Company: Building and supplying the main mission antennas that provide the direct communications links between the satellites and hand-held IRIDIUM subscriber units.

Lockheed Martin Missiles & Space: Providing the 'bus' section of each of the 66 satellites. This includes the satellite structure, power system and attitude control system. In addition providing support for system engineering, integration, test and assembly.

Scientific Atlanta, Inc: Designing and manufacturing the earth terminals which will control the satellite constellation and provide full duplex communications with IRIDIUM system satellites.

Siemens AG (Germany): Developing and supplying the mobile telecommunications switching systems and related services for terrestrial gateways. The switching systems used for the IRIDIUM system are members of Siemens' EWSD-based D900 mobile services switch family.

Hewlett-Packard Company: Designing, developing, manufacturing and integrating special test equipment systems to be used to verify functionality of many of the IRIDIUM satellites and system components.

Telesat Canada: Designing, building integrating and operating telemetry, tracking and control (TTAC) facilities. Also providing geostationary satellite communications links between the TTAC sites, the SATCOM Control Center and the Master Control Facility.

ARINC, Inc: Engineering and developing the control segment network management system, also providing system engineering and architecture expertise.

IEX: Designing the system's call processing system, jointly with Motorola Satellite Communications Division. Also defining specifications for the complex interactions among subscriber units, gateway elements and space elements.

Integrated Systems: Providing the MATRIXx design tools used to simulate the entire IRIDIUM system handling millions of calls per minute.

Software Technology, Inc: Providing the satellite/ground control system software, based on OS/COMET, and associated ground support infrastructure for the IRIDIUM satellite constellation.

Essex Corporation: Contributing systems engineering and high fidelity performance modelling in areas including system capacity, messaging, interference and resource allocation, crosslink routing, channel management and handoff operations.

Construction continues

A variety of construction projects are also nearing completion around the world. The Master Control Facility, which is located in northern Virginia, outside of Washington DC, USA, was completed last May, and staff is scheduled to move in during the fourth quarter. This facility will track the constellation of IRIDIUM satellites.

The Master Control Facility will be supported by a backup control facility in

Rome, Italy. Negotiations were recently completed with Nuova Telespazio, which entered into a contractual relationship with Motorola to construct and operate the backup control facility. Nuova Telespazio will also be responsible for operating the facility, which is scheduled for completion during the first quarter of 1997.

Eleven contracts have been signed for gateways that will connect the IRIDIUM constellation to the public-switched telephone network. A generic gateway design was completed in the last quarter of 1995 as a model that gateway operators can adapt to their site. The goal of the design is to provide gateway operators with guidelines for lightning protection, grounding, equipment layouts, and room configurations.

Last February the first groundbreaking ceremony for an IRIDIUM gateway was held in Matsumoto City, Japan, which is also the site for the 1998 Nagano Winter Olympics. The site was selected for its proximity to Tokyo, Osaka, and Nagoya, where international calling traffic is heaviest. It was a special groundbreaking because it included a traditional Shinto ceremony. Shinto is the oldest surviving religion in Japan and the ceremony included a purification ritual and a blessing by a Shinto priest.

The first North American gateway for the IRIDIUM system will soon be completed. Located on six acres at Arizona State University Research Park in Tempe, Arizona, USA, this facility will be operated by the North American consortium, which includes Motorola, Sprint, and Bell Canada. This gateway will tie the IRIDIUM constellation to North America. The $1860m^2$ headquarters is scheduled for completion at the end of the year. Equipment is scheduled to be installed by mid-1997 and testing is scheduled to begin later that year.

The IRIDIUM system's Telemetry, Tracking, and Control (TTAC) facilities will be ready for operation shortly. The TTAC south facility, which is located in Oahu, Hawaii, USA, was recently completed.

Applications were filed with the US Federal Communications Commission for a licence to construct and operate the IRIDIUM system's transmit-receive fixed earth station facility in Hawaii and Arizona.

The TTAC west facility, which is located in Yellowknife, Northwest Territories, Canada, is also complete. The electronics equipment has been installed at TTAC west and the facility was linked both by terrestrial landline circuits and by geostationary satellite to Motorola's Satellite Communications Division in Chandler, Arizona, USA. These links allow further integration and testing of TTAC west with other system elements.

Construction is also now complete at TTAC east, which is located in Iqaluit, Northwest Territories, Canada. In addition, construction has been completed on the Transportable Tracking System facility in Iceland. All facilities will be operational for first launch later this year.

Conclusion

Now entering its fourth year of development and construction, the IRIDIUM system remains ahead of schedule. In 1998 this new form of global wireless telecommunications will be available to anyone. For the first time in the history of telecommunications, a handheld telephone will be available to make or receive calls from anywhere in the world. *Published by arrangement with Iridium, Incorporated. Some of this material is reproduced from 'IRIDIUM Today', with permission. All pictures are reproduced by courtesy of Iridium Inc. Our grateful thanks to John Windolph and David Savold of Iridium Inc., for their help in preparing the article.* ❖

SHORTWAVE LISTENING

with Arthur Cushen, MBE

Preservation of radio history is essential

As it is now more than 100 years since Marconi patented his radio transmission idea, a lot has happened in radio history. It is pleasing to note that there are areas in which this history is being retained, in printed form and also in sound recordings. In New Zealand, this activity of the New Zealand Radio DX League climaxed recently when a tremendous amount of archive material in the form of verifications, letters, cards, scrapbooks, albums and the like was handed over for permanent storage at the Hocken Library in Dunedin, a part of the Otago University.

The Hocken Library owes its existence to the vigorous collecting and subsequent generosity of a Dunedin doctor, Thomas Moreland Hocken (1836-1910). Hocken applied his drive and talent to the acquisition of books, newspapers, maps, pamphlets, photographs, pictures and artifacts relating to New Zealand, the Pacific and early Australia.

The Hocken Library is not a library as such, it is a depositry for archival material stored under excellent conditions and the New Zealand Radio DX League were pleased to have the library accept our history of radio listening. The material presented goes back to the early 1920s, and for students of communication offers an ideal opportunity to trace broadcasting in New Zealand and overseas.

The collection had been stored in Oamaru, and under the control of Peter Grenfell had been housed in members' homes until it reached such an extent that it had to be housed in a permanent home. Members had died and left their material to the League, estates had been wound up with the DX League being the beneficiary, and so in keeping with the wishes of the benefactors this move to a central position has overcome many problems.

The presentation of the NZ archive material to the Hocken Library was subject to television, press and radio coverage. It appeared in part of 'Sounds Historical', a Sunday programme between 0800-1000UTC which is carried on RNZI on 6100kHz, and on the National network within New Zealand. In the programme Jim Sullivan the presenter usually highlights sound recordings of the past, going back to the 1930s. It was fitting that this move to the Hocken Library was also part of his weekly programme.

Band expansion

In the May issue, we commented on the expansion of the AM band in North America to 1700kHz and in Australia to 1705kHz, and reported on the reception of stations in this band. A letter from the Director of Engineering of the Australian Broadcasting Authority in Canberra points out that the expansion of the band in Australia is limited to a certain class of broadcasters.

In his letter, Mr Greeney said *You may have been referring to recent developments approved by the Australian Spectrum Management Agency (SMA), which permit narrowcast services to operate in the medium frequency band, just above the upper end of the AM broadcasting band, with centre frequencies at 9kHz intervals from 1611 to 1705kHz...*

Narrowcasting AM services licensed by the SMA for use in the medium frequency band 1611kHz to 1705kHz are strictly limited in their maximum permitted radiated power, and have much narrower bandwidth limitations imposed on them than apply to broadcasting stations operating in the AM broadcasting band. ❖

AROUND THE WORLD

COLUMBIA: HJJW, Radio Emisora, Nuevi Continente, is a medium wave station operating on 1460kHz with 15kW. The surprising verification from this station, in the form of a letter, photos, stickers and audio cassette was received from a report of April 1989, some seven years and two months after the letter was posted to HJJW.

COSTA RICA: The relay base of Radio Exterior De Espana has been heard on several frequencies. They use 9620kHz from around 1030UTC while the channel of 3210kHz has been heard in Spanish from opening at 1100UTC to closing at 0400. All programmes are relayed from the Madrid studios.

ECUADOR: HCJB, Quito in its broadcast to the Pacific 0700-1130UTC has made a frequency change to 9445kHz. The old channel was 5900kHz and it is understood that this caused some interference to radio transmissions in the South Pacific — forcing the frequency change.

HUNGARY: Radio Budapest has been received at 0230-0300 on 9840kHz. The schedule is 0100-0130 and 0230-0300 on 9840 and 11,870kHz to North America, and to Europe 1900-1930 on 3975kHz, 6140, 7130 and 9835kHz.

IRELAND: A letter from Michael Commins of Mid West Radio indicates there was worldwide interest in the special St Patrick's Day broadcast, when a BBC transmitter at Woofferton was used on 11,715kHz and widely heard in the South Pacific area. Mid West Radio plans to run a similar broadcast in 1997 and if funding or sponsorship for the programme is secured, a weekly or monthly broadcast would originate from Mid West Radio. Verification was in the form of a letter, card and sticker, and a newsletter concerning the station's operation, which is on FM.

ISRAEL: IBA, Jerusalem is using 7465kHz in English at 0400-0415. This is a clear channel, as Norway has moved to 7520kHz, but the best signal from Israel is still on 9435kHz.

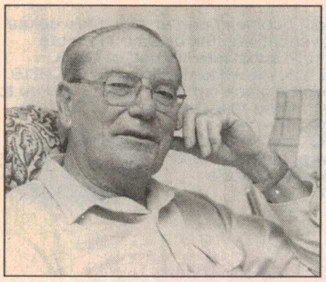
PHILIPPINES: FEBC, Manila broadcasts in English to the South Pacific 0930-1100UTC on 11,640kHz, a slight move from 11,635kHz. Another interesting signal is on 9405kHz, when the broadcast is in Chinese from 0859UTC.

SOUTH AFRICA: Channel Africa at 0500UTC is heard with three different language broadcasts. English is on 9590kHz, French on 9525kHz and Portuguese on 7185kHz. The future of Channel Africa is in doubt, as the new government is looking at the operation of shortwave service from Johannesburg.

UNITED KINGDOM: The BBC has produced a new programme magazine *BBC on Air*, and of interest to shortwave listeners is the fact that all the transmitter sites are shown against each frequency. A summary of the sites used by the BBC Service shows that they have transmitters in the UK and at the following sites: Ascension Island Canada, Caribbean, Cyprus, Hong Kong, Japan, Korea, Lesotho, Oman, South Africa, Seychelles, Singapore and USA. BBC World programmes are also relayed by transmitters in Australia, Nepal and New Zealand.

ZAMBIA: Lusaka is being heard on 4910kHz from 0500 and also around 2000UTC with its Radio One programme. Signals have been improved following the installation of two 100kW Chinese transmitters which are now in operation. Christian Voice from Lusaka is using the new frequency of 3330kHz from 0400-2100UTC, and is received during the last part of the transmission. ❖

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 10 hours behind Australian Eastern Standard Time and 12 hours behind New Zealand Standard Time.



When I Think Back...

by Neville Williams

Ferris Bros Radio, a prominent Australian firm: but the truth is stranger than fiction! (2)

From the humblest of beginnings, Ferris Bros. Radio battled on through World War II, with radio assuming a distinctly limited role in its affairs. After the war the situation changed, with a strong emphasis on portable and car radios, backed up by a nation-wide involvement in TV components and antenna systems. In the ultimate, however, Ferris Industries acquired new owners and a new identity and effectively disappeared into outer space!

From the very outset in 1932, Chum Ferris planned to build household radio receivers which would carry the family brandname, as well as marketing and servicing as many other brands as might become available. Significantly, he took time out to fit a radio set into the Company's ancient Hupmobile tourer, demonstrating thereby an underlying interest in radio in 'the great outdoors': cars, caravans, boats and weekenders.

However, while the Company picked up a few related orders in the early days, technology in the '30s was heavily biased towards conventional household radios, and by the time the way had opened up for mobile or portable receivers, wartime regulations had severely curtailed all civilian radio production in Australia. But not surprisingly, once the restrictions were finally lifted Ferris lost no time moving back into this specialised field.

In a promotional brochure *The Ferris Company 1932-1964*, they claimed that their postwar 'portable' receivers had already gained a reputation (I quote) 'as quality products or, as some say, the Rolls-Royce of car radios'. Their contemporary sales literature was proudly emblazoned with two distinctive circles, one emphasising the name FERRIS, the other AUSTRALIAN MADE.

The brochure also claims that the Ferris model 74, produced in 1947 under the personal supervision of Chum Ferris and F.B. Allison, had been the 'world's first genuine portable car radio'. Admittedly its chunky shape was still reminiscent of a mantel radio, but it was small enough and rugged enough to withstand any likely amount of handling and bumping around in a road vehicle.

Using six 6.3V valves and a vibrator HT system, it could be bracketed into a car and powered from the car's own electrical system — be it 6V or 12V, negative or positive earth. Its copper plated steel case and internal filtering served to attenuate ignition noise. It could as easily be transferred into a boat, a caravan or a holiday cottage for normal family listening, a DC/AC switch allowing it to operate either from an alternative battery supply or from the AC mains.

Featured freely on Company literature were twin circles displaying 'Ferris' and 'Australian Made'. Ferris were justifiably proud of their heritage, their reputation, their staff and their products.

At a time when radio was a vital source of news and entertainment, yet normally so very 'non-portable', the Ferris concept had obvious consumer appeal.

Variations on a theme

A check through old leaflets uncov-

Ferris Bros' Head Office and No.1 Factory in Pittwater Rd, Brookvale (Sydney) — occupied in 1953, and subsequently extended to embrace their ever more demanding products and facilities.

ered a range of derivatives from the model 74, including one using a reflex circuit to reduce the valve complement to five — in order to lower the price. There was a compact version to suit small English cars, and another adapted for remote cable control from the steering column. Yet another provided for an extension loudspeaker system, for use in tourist coaches.

A couple of models featured a shortwave band, the 'outback' version offering reception of the Flying Doctor, Bush Fire Control, Police and Ambulance. Some models also included an economy switch, to reduce the current drain when the full potential of the receiver was not required.

At the time of initial release the basic model 74 was priced at 39 guineas (£40-19-0). The introduction of transistors around 1959, the adoption of printed circuit boards and other technological developments saw the subsequent release of more efficient and more attractively styled Ferris 'car/portable' radios, with minimal increase in the price relative to prevailing wage levels.

Model 184 (1962-64) typifies the styling which dominated the solid-state era. In a car, it could be supported under the lower lip of the facia panel. In other situations it could be carried by the handle as a self-powered portable, or perched upright on a shelf or table top for family listening.

Over the years, Ferris produced an impressive sequence of both portable and 'fixed' auto receivers with the design emphasis variously on RF gain and selectivity, multiband coverage, push-button tuning, audio performance and so on. Normal and/or key-locked cradles were made available, with a variety of fitting accessories, escutcheons, antennas, plugs, cables, extra loudspeakers etc., to suit most vehicles on Australian roads.

The Ferris No.2 Factory in nearby Mitchell Rd, Brookvale. Commissioned in 1956, it was devoted mainly to metal working processes to do with TV antenna engineering.

Backup service

Typically, a Retailers Price List to hand dated July 1967 offered about a dozen different Ferris models, with and without accessories. Supplementary literature listed a couple of conventional transistor portables, a 'Gemini' twin speaker mantel set and an odd gadget called a 'Tranimate'. Used with a gutter-grip antenna, the latter could receive signals from outside a car and feed them to an ordinary transistor set inside, thereby minimising the ignition hash that might otherwise obliterate the program.

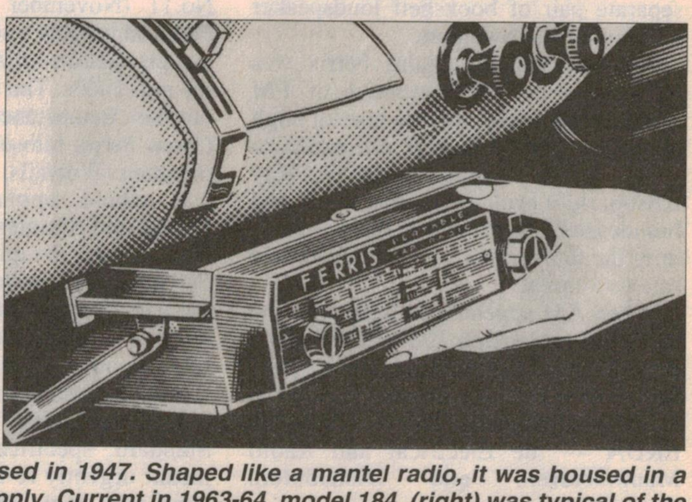
If that seems somewhat 'over the top', what about a four-speed portable record player that could transform a car radio into a portable radiogram — presumably for use on a picnic or holiday outing.

Thumbing through the literature, one repeatedly comes across evidence that Ferris Industries were very serious about performance and quality control, in terms of equipment, facilities and personnel.

All receivers, they emphasised, were subjected at the factory to vibration, voltage, temperature and humidity tests to ensure that they would cope with conditions likely to be encountered in everyday useage. As for field service, the literature on loan from Chum Ferris contained typical service manuals relating to individual models, while a brochure listed 300-odd accredited service centres spread around Australia.

Ferris were proud in 1969 when *Choice* magazine, published by the Australian Consumers Association, specially commended their Volumatic II series of car radios, after detailed comparison with other currently available brands. Furthermore I gather that they were featured in the Montreal EXPO.

In the literature I also encountered



The first Ferris portable car radio model 74 (left) was released in 1947. Shaped like a mantel radio, it was housed in a plated steel case and included a built-in vibrator type HT supply. Current in 1963-64, model 184 (right) was typical of the styling that won Ferris industry awards and a substantial share of the Australian auto/home/portable market.

Set up for the first postwar Sydney Royal Show — the traditional image of Ferris as EA's older readers will remember it. The model trains are displayed on the tabletop on the right.

references to products that I'd either forgotten — or didn't know about in the first place. There was, for example a reputedly popular range of 'Marina' marine transceivers, PMG approved 'for small ships'. A (then) recent addition to the series detailed in *The Ferris Wheel* (No.11, November 1967) offered 8-channel coverage, crystal locked circuitry, an RF output of up around 150 watts, and a remote control unit. Fibreglass whip antennas, which could be lowered conveniently to clear obstructions, were said to be available for the series, plus a whole range of boating installation extras.

(This is not to be wondered at because, according to the Penta Comstat *Beacon*, Chum and his wife ('mate') Joan had been 'boaties' for decades with their cruiser *Tempest*, replaced in 1971 with the more pretentious *Barrine*. Nowadays, in 'boatie' terminology, they have apparently 'swallowed the anchor' and substituted a golf course for the blue water, and amateur bands for the boaties' network).

In the same publication, there is mention of the Ferris M-200 series of 'Easybeat' portable mains-powered record players, of which I also had no previous knowledge. A new stereo model 500 is said to have been released, styled along similar lines in a neatly finished portable case. In the stereo version, one loudspeaker had been housed in the body of the unit, the other in the removeable lid. For use in the home, a separate pair of bookshelf loudspeaker enclosures was available.

Not surprisingly, Chum Ferris was well aware of the potential of FM broadcasting, with its promise of high quality, noise-free sound, ultimately in stereo. He had supported the late Ray Allsop, right back to the time when AM broadcasters were doing their best to turn the politicians against what they saw as a threat.

When AM appeared to have won the day by side-tracking FM to UHF some time in the distant future, Chum publicly rejected the proposal, both as a major manufacturer and an officer of ERDA — the Electrical and Radio Manufacturers and Distributors Association.

Writing in *Mingay's Electrical Weekly* (March 9, 1962) — with Os Mingay's personal support — he detailed his findings in the USA, where he had been researching TV antennas with Channel Master, 100 miles west of New York. Quoting figures from the FCC, the Americans, he said, had successfully accommodated more than 10 times as many VHF TV stations as proposed by Australia, while also setting aside a VHF broadcast band, currently occupied by 195 FM broadcasters. Unlike the AM stations, they were virtually noise-free.

As it turned out, the Federal Government later reversed its decision and legislated Australian FM broadcasters into what had become the *de facto* international FM Band.

Allied Capacitors

Returning to *The Ferris Wheel*, issue No.11 (November 1967) summarised Ferris Industries' successful venture into the production of Allied Capacitors in the mid 1960s. The article does not spell out the circumstances and, 30 years on, Chum Ferris himself is hazy about the commercial details.

It would appear, however, that Ducon and Simplex had run into problems, raising the question as to whether Ferris/Telecomponents could help fill the gap. Whatever the details, the challenge — spelled out by Alleyne Bowler (ex Ducon) — was to meet the electronics industry's need for improved capacitors with tougher 'Military Standard' specifications. For Ferris it meant urgently re-training operators to cope with new and more demanding production technology.

Acknowledging — typically — their ultimate reliance on reliable staff, the Ferris newsletter pictures Anka Obatrov and Rose-May Ringuet operating plastic film winding machines; Ayesha Easlea tab welding; Sylvia McColl performing a control lead strength test; and Departmental Supervisor Pam Loveday operating tell-tale capacitance measuring equipment. Also mentioned in this context was Chief Engineer Karl Trankle and trainee engineer Kevin Charters.

Credited as prime sources of the production 'know-how' were TCS for polystyrene capacitors; Fischer & Tausche, electrolytics; Shinmei Electric, trimmer capacitors; Shizuki Electrical, plastic including lacquer film capacitors; and Johnson Matthey & Co, for silvered mica types.

Back in the 1960s, I vaguely recall Geoff Wood offering me over the counter at RDS (Radio Despatch Service) capacitors that were agreeably small and well rated when compared with the traditional bulky Australian eqivalents. Here I am, 30 years later, tracing or re-tracing them back to Allied, Telecomponents and Ferris Bros — the multifaceted company out Brookvale way!

Channel Master antennas

But if mobile radio and the Telecomponents arm of Ferris Industries loomed large, the agreement that Ferris signed back in the 1950s with Channel Master must surely have out-loomed them! In *The Ferris Company 1932-64*, the writer remarks that Channel Master (Aust) Pty Ltd, in

respect to TV antennas and accessories, gained the manufacturing rights to 'everything but the roof!'

In the USA, Channel Master had had the opportunity to document the role of the antenna in a huge number of installations and environments. They had access to an 'enormous' test range in the Catskill Mountains, New York State, where the gain, frequency response, directivity, front/back ratio and impedance of arrays could be measured and plotted.

The resulting expertise became available to Ferris, and gave them a head start when they pondered the congested mix of stations and channels down the mountain-strewn East Coast of Australia (see illustration). Ferris were in the fortunate position of having lab facilities and knowledgable staff, qualified to debate problems and solutions with their counterparts in New York State.

Ferris' No.2 factory in Brookvale, NSW, had been expressly set up to manufacture TV antennas and the bits and pieces that were part of the installation process. They had agents and service centres who could alert them to problems and problem areas.

They also had survey vans which could be despatched into new or problem TV areas. Fitted with a telescopic tower, the vans could be fitted with antennas of one kind of another, with appropriate equipment in the van to observe and measure the incoming signal(s).

Nor was it a lop-sided arrangement, as far as Ferris and the US Channel Master were concerned. In the brochure *The Crossfire Story*, Chum Ferris, as a Member of the IREE Aust. and Technical Director of Channel Master, tells how he spent time in the US laboratory (August/September 1961) adapting the 'Crossfire' range of antennas to frequencies that had been provisionally earmarked for channels 4 and 5 in Australia. All six models of the Crossfire series were modified successfully, without compromising their normal hi-band and low-band performance, thereby fitting in with the policy of Channel Master (Aust) to major on all-band antennas. They were so successful, in fact, that the Americans realised that they could offer the same designs in the USA as universal TV/FM antennas.

In *The Ferris Wheel* for November 1967, Kevin W. Hill, General Sales Manager, observes that with new stations coming on air and the prospect of an ultimate colour service, the days of 'any so-called TV antenna' or any gimmicky indoor gadget had passed. Channel Master had developed and could supply properly engineered antenna systems optimised for weak signals or strong signals, whether subject to ghosts or not, on specified channels and sited fortuitously or otherwise. I gather that in order to cater for TV reception areas Australia wide, the Channel Master inventory of models topped the 100 mark, ranging from the simplest design to 20-odd elements.

They were also able to offer masts, rotatable beams, cables, splitters, line amplifiers and community systems, where appropriate.

(Although identified as General Sales Manager, Kevin Hill himself had a technical background, with tech college training in Melbourne and Sydney and radar service in the Armed Forces during the war.)

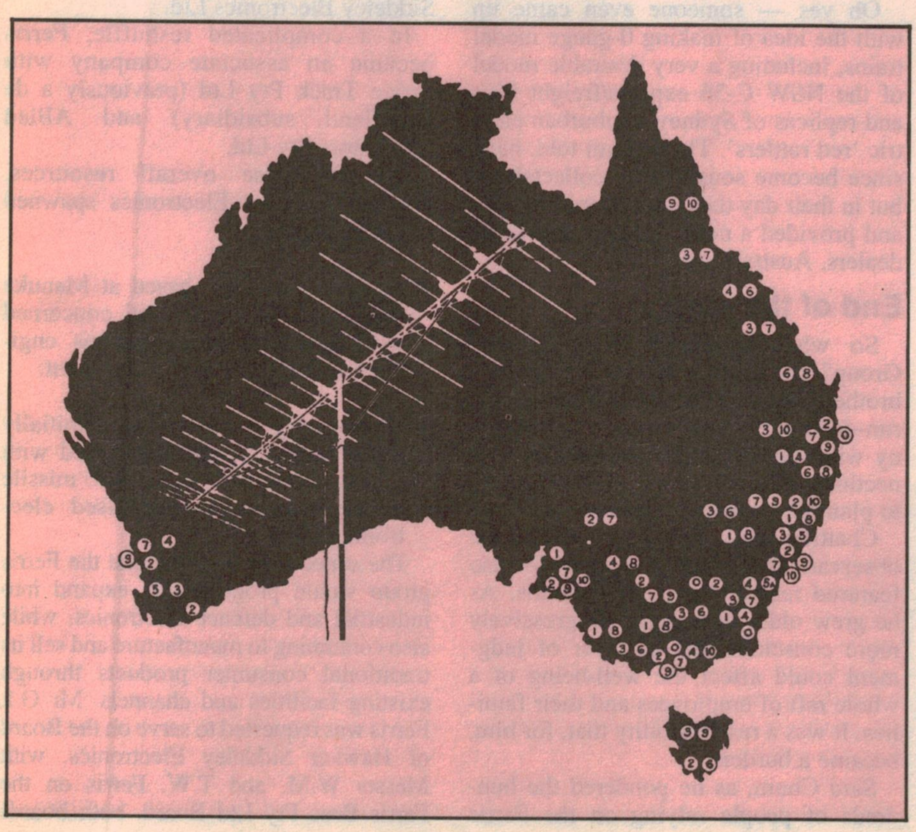
Channel Master antennas not only dominated the Australian scene but led to overseas connections. Ferris Industries cooperated in the establishment in Auckland of Channel Master (NZ) Ltd, holding one third of the share capital. It proved to be a very successful venture.

In 1963 Ferris, in conjunction with local interests, also formed Ferris Industries (Malaysian) Ltd, to assemble and market Channel Master products in Malaysia and Singapore. Key personnel were seconded to Malaysia/Singapore to familiarise the staff with Australian products and services. The General Electric Co. subsequently purchased a majority interest, but Ferris retained its original shareholding of 100,000 Straits dollars.

In the mid 1960s, Ferris Channel Master concentrated on both MATV (master antenna TV) and CATV (community antenna TV). In 1967 they produced a special handbook on MATV, detailing the special considerations affecting multiple TV sets required in hotels, motels, blocks of flats, etc. Of special interest was their combination of the Crossfire 3606A — claimed to be 'the World's most powerful TV antenna' and a built-in Telstar signal booster, said to be lightning-proof and fed from a readily accessible power supply within the building.

1969 saw the release of a new series of solid-state MATV amplifiers offering higher gain, lower noise and a strong emphasis on reliability.

CATV commonly addressed the problem of multiple separate homes or apartments which needed to share access to one strategically placed antenna to gain acceptable reception. Classical examples occurred in NSW coastal areas where waterside homes were shielded from TV transmitters by steep and lofty cliffs.



From 'The Ferris Wheel', a TV map of Australia showing the VHF channels, actual and planned. Some areas require a large, complex array, as implied by the superimposed sketch.

Staff relationships

In the matter of personnel, it is evident that the Ferris Group did not share the cyclical hire-and-fire attitude that has been mentioned from time to time in these columns.

John Emanuel, who cooperated in the preparation of this article, served much of his formal apprenticeship with the Company and there is photographic evidence in the literature that, at any one time, there would be a dozen-odd apprentices in training. If they had formal obligations to the Company, the reverse was also true.

Factory photos also indicate a generous percentage of women operators on the production lines. Looking back, Chum Ferris recalls that the Company had a very good relationship with women in the area. They were grateful for the opportunity to supplement the family income, and generally cooperative in adapting to the peaks and troughs of production schedules.

In any case, it was in the interest of Company shareholders to keep the factory operative and the staff busy. In the early days, they had deliberately diversified into radio service, electrical service, refrigeration and even the odd spot of plumbing.

The need to keep the factory occupied had led them into producer gas generators, interspersed with mechanical service on the vehicles being so fitted.

Things had gone well with car radio, but TV set production had been a disaster. They gave it up, but resumed some months later when they got the opportunity to supply sets to a couple of TV rental groups with reliable finance.

They had also contracted to build special professional equipment, such as an electricity meter checking system for EMMCO/EMAIL and an Audiometer, as used by specialists to measure the acuity of patients' hearing. For good measure, add two-way VHF radio for light planes, laboratory power supplies, battery chargers for home handymen, and the Ferris 'Fireplus' transistorised ignition system. Chum stressed in conversation that they had long term plans to expand and develop custom-built high tech products.

Again, when the No.2 factory had capacity to spare, Mr J.L. ('Jack') Ferris — a cousin to the brothers — cast around and produced a 'Coursemaster' golf buggy and a selection of road trailers. They also came up with a range of six 'Tiltmaster' boat trailers, with winches and boat hooks to suit, along with folding canopies. Like the golf buggy, the boating equipment tended to peak in summer, when interest in radio and television tended to taper off.

A typical group of 14 Ferris aprentices, distinguished in their shirts and 'string' ties. John Emanuel, who owns the picture, is in the back row, second from the right.

Oh yes — someone even came up with the idea of making 0-gauge model trains, including a very desirable model of the NSW C-36 express/freight loco and replicas of Sydney's suburban electric 'red rattlers'. These, I am told, have since become sought after collectables; but in their day they kept operators busy and provided a novel sideline for Ferris dealers, Australia-wide.

End of the story

So what happened to the Ferris Group? The short answer is that the two brothers, having battled their way from a run-down shop in Mosman to a company with national and international connections, reached an age where they had to plan for ultimate retirement.

Chatting with 'Chum', I recalled the observations of Arthur Spring — also featured recently in these columns. As he grew older he became progressively more conscious that an error of judgment could affect the well-being of a whole raft of employees and their families. It was a responsibility that, for him, became a burden.

Said Chum, as he pondered the hundreds of people relying on the Ferris Group, "I can identify with that!"

Sufficient to say that in 1969 the shares in Ferris Industries Ltd were acquired by Hawker Siddeley, such that it became a subsidiary of Hawker Siddeley Electronics Ltd.

In a complicated reshuffle, Ferris became an associate company with Space Track Pty Ltd (previously a de Havilland subsidiary) and Allied Capacitors Pty Ltd.

Out of these overall resources, Hawker Siddeley Electronics spawned two new Divisions:

- Systems Division, based at Manuka ACT and elsewhere, and concerned with space tracking, systems engineering and systems management.

- Engineering Division, based initially at Salisbury SA and concerned with defence electronics, guided missile development and specialised electronic products.

The stated intention was that the Ferris group would progressively expand into industrial and defence electronics, while also continuing to manufacture and sell its traditional consumer products through existing facilities and channels. Mr G.I. Ferris was requested to serve on the Board of Hawker Siddeley Electronics, with Messrs W.M. and T.W. Ferris on the Ferris Bros Pty Ltd Board, both boards

being under the chairmanship of Mr Rollo Kingsford-Smith.

The last copy of *The Ferris Wheel* to hand from Chum Ferris is dated March 1971, with 'Hawker Siddeley Electronics' added to the masthead, along with a trade mark contrived from the initials HS. Inside is a mixture of items from Ferris and HS, including a release item about the new award winning 'Volumatic' Ferris car radios.

It was in accordance with forward planning but, with hindsight, one could but speculate whether the Directors had any notion of the Federal Government's tariff reductions that would shortly devastate radio production in Australia. Or that, despite Ferris' moves to automate, complete Asian-built receivers would ultimately be imported for less than the cost of the parts needed to build them here.

Again, whether the negotiators had fully appreciated the enormous gulf between consumer products and space hardware. With that thought came the conviction that Ferris was in danger of becoming a mere segment of a very complex wheel: 'the Ferris cog'!

As if to emphasise the point, *The Ferris Wheel* for November 1970 had featured Hawker Siddeley Electronics' deep involvement in the Tidbinbilla space telescope in the ACT — a very odd partner indeed for the traditional Ferris marketing enterprise.

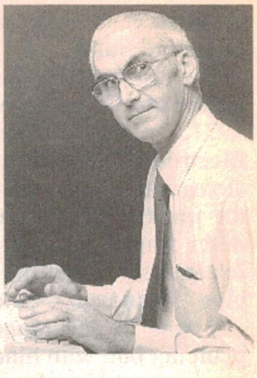
What happened to Ferris/Hawker Siddeley/De Havilland in the next couple of decades is quite another story, which I have not followed up in detail. Sufficient to say that when I asked John Emanuel — now a car radio specialist — what had become of Ferris and their award-winning 'Volumatics' he was very sad. The proudly Australian made Ferris range had given way in the marketplace to a much less distinctive Asian import.

As to the Brookvale complex itself, Bob Ditchburn — who worked with Ferris for best part of 30 years — tells me that the number 1 factory and Head Office has recently been bulldozed out of existence, while the buildings that comprised factories 2 and 3 are apparently industrial real estate occupied by sundry tenants.

I remember visiting the Tidbinbilla space station some years ago, and was suitably impressed by what I was shown. I recall nothing, however, to suggest that it had ever had anything in common with Ferris industries. Intentions and plans notwithstanding, Ferris Industries has seemingly disappeared into space in more ways than one! ❖

FORUM

Conducted by Jim Rowe



Pay rates for electronics technicians: readers lend their support to 'P.R.'

There's been a fairly strong response to the letter I presented in the June column from 'P.R.', complaining about Australia's relatively low pay rates for electronics technicians and other technically trained people. We've also had an interesting response to Alan Elliott's letter in the March issue, regarding the safety of smoke detectors containing radioactive Americium 241, and I'm also taking the opportunity to present a letter from a reader concerned about what he found inside a passive IR detector...

If you read this column in the June issue, you'll no doubt recall the letter from 'P.R.' of Crows Nest NSW, about pay rates for electronics technicians and other technical people. It was written shortly after the reader concerned had returned to Australia after some years working overseas, and reflected his shock at discovering how low the pay rates had remained here — 'pathetic' was the word he used to describe them.

His letter was written with a great deal of feeling, and it's not surprising that it produced a response from other readers. Here's a letter that arrived soon after the June issue was published, from a reader in South Australia identifying themselves as 'J.D.':

In regards to the letter in the June issue of your magazine titled 'Should electronics technicians be paid more than street sweepers'. Hear, hear — yes they should.

I'm an electronics technician employed by one of South Australia's larger repair companies, repairing the full range of domestic audio visual equipment. I have been in this trade since 1982. In the last 10 years my wage has increased by only $3.00 per hour, to a massive 'just under' $14.00 per hour for a 38-hour week. Not much for a person paying off a mortgage.

My wife earns more than I do, and she is only a secretary ('admin assistant' to be politically correct). Sufficient for us to consider that I stop work when our first child arrives and become a house husband. At the rate it is going, we would be better off if we went back to farming. At least there you only have the banks and nature to contend with.

The 'Mr Fixit' title is still very evident, but to fix modern electronic equipment you need to be both mechanically and electronically inclined. The study required to repair this equipment is more than you need for some degrees. To get where I am I have done approximately 7-1/2 years of study, part and full time.

The complexity of a modern TV is far beyond the Back Yarder, yet to try to fix a video camera can cause big headaches even for people with the test equipment.

This industry has long been in need of an upheaval. The idea of a licence to me is a good one, but only if it includes the technicians that are industry trained, the ones with the know-how but not the paper to prove it. I know of a few of these people and they are all good techs.

This idea of individual workplace bargaining is good if you are a good negotiator and you have work conditions that can be negotiated. The best thing at the moment is the government should enforce the award conditions, both Federal and State. To negotiate a workplace agreement is not for a person who is lowly paid in the first place. Unions would be great if there was one that covered this industry properly, let alone recognised us as an industry.

My place of employment is at the moment turning over well in excess of $120,000 per month, and is growing. A bigger piece of that pie we are fighting for, but not with much success. No wonder we can't find technicians. I don't blame any young person for not wanting to enter this trade, as you can get better pay working as a shop assistant, e.g. my weekly turnover is over $3000 per week, with last month turning over more than $15,000 personally. To work harder may be possible, but not if there's no more money.

Hmmm — as you can see, J.D. is pretty well in agreement with P.R., on all counts. And without wishing to denigrate the level of committment and hard work involved in secretarial (sorry, administration) work, any more than P.R. was denigrating the work of street sweepers, it does seem unfair that people performing these jobs can earn significantly more that technicians with a high degree of knowledge and skill in electronics or a similar technical vocation. Wouldn't you agree?

Further support

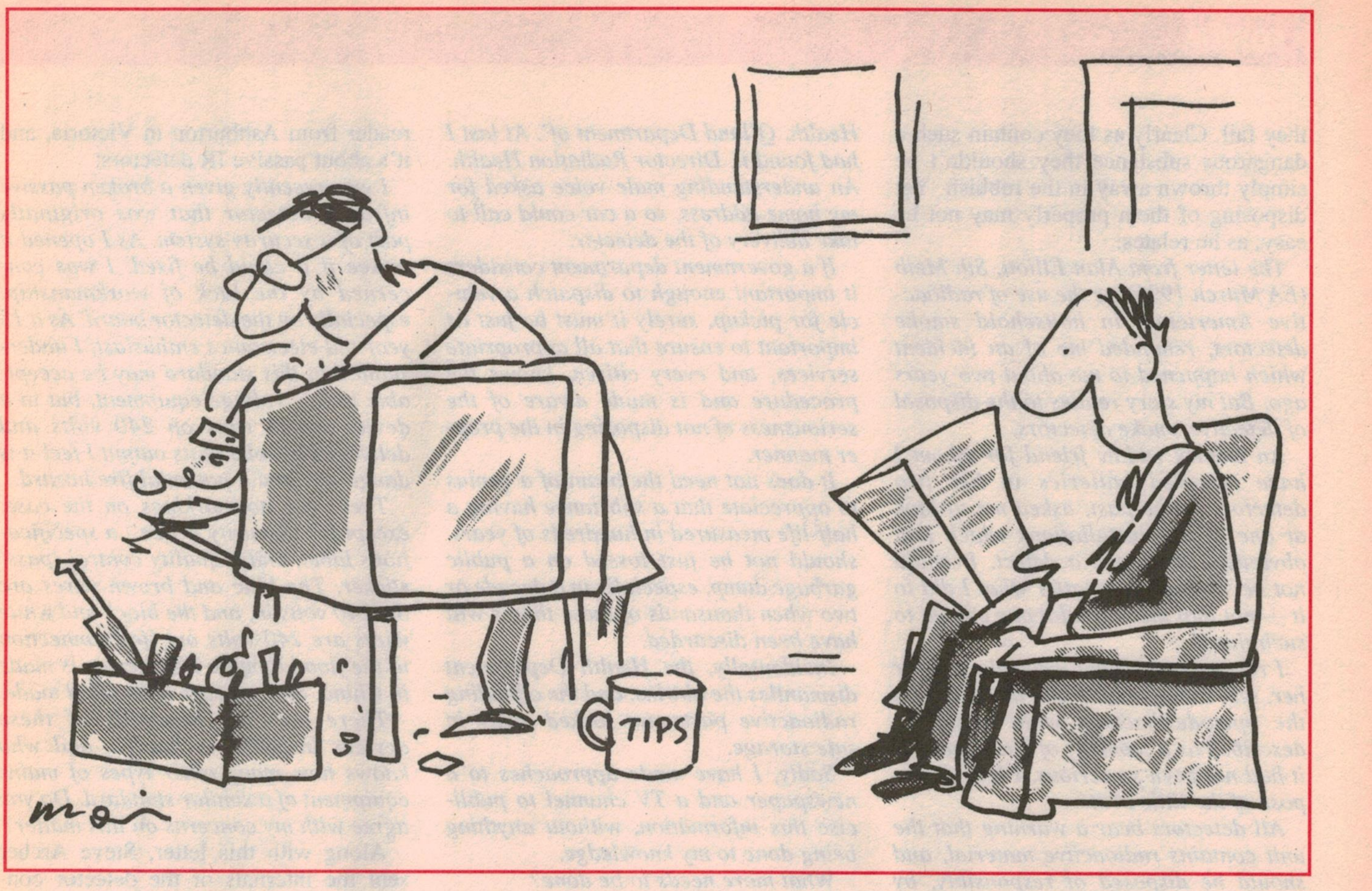
Anyway, here's another response in similar vein. This one comes from Mr E.L. Scharenguivel, of Cloverdale in Perth, WA:

I fully agree with the comments made by P.R. about the status and pay for technicians. When I arrived here some 35 years ago, I found the attitude was that technicians belonged to the 'lower classes' — you worked with your hands like a 'grease monkey', and should be paid peanuts.

My last position was in government service, and I was not popular with the hierarchy for being critical of the anomalies — like why we had a different set of rules for civil servants. Weren't we all government workers? A classification such as 'Day Labour' for workers would imply that we were perceived to be what in Asian countries was called 'Coolie'!

When I first started in the trade there was little else but radio and I was known as a radio mechanic. As we all know things have changed since those days, but technicians are still regarded as people with only basic skills.

A former Minister in the Whitlam Government, Clyde Cameron, wrote a



few articles in the local press (Sunday Times) a few years ago, and he mentioned THEN that if the workers had kept pace with the public servants, an electrical fitter would be on $600 per week. We were tied to the Accord, limiting pay increases to the cost of living — but the public sector and executive salaries skyrocketed!

In spite of all the Equal this and Equal that tribunals, nothing has changed.

Thank you for those comments too, Mr Scharenguivel. It does seem that the skills of technical people are discounted in comparison with many other occupations, doesn't it?

Somehow, this mistaken view needs to be corrected. It's a pity that the various technician organisations haven't been able to do more of a 'selling job' in this regard, to change the public perception of their members and the skills they possess.

Not just electronics

Our third response shows that it isn't only electronics technicians, or even Australian technicians, whose salary levels are unrewardingly low. It comes from Mr P.A. Hutchings of Palmerston North in New Zealand, who writes:

Regarding the letter in your June Forum, if you think that electronics servicemen are the only ones that are poorly paid, check the motor and allied trades. I think you'll find that their pay is on a par. Electricians (sparkies) seem to fare slightly better, but most tradesmen seem to be the poor relations as far as income is concerned.

This is due, I think, to the attitude some people have that anybody with a few clues and two to three years' secondary education can do the job, as well as a university trained electronics enginner — but on a labourer's pay (or less). There's also the view that tradesmen should not be considered too highly because if they are paid too highly, the costs of repairing those cheaper devices would be too high when profit margins are added. The shareholders must have their dividend...

I am sorry if I am getting rather cynical with age, but only shop assistants and process workers get less.

Some time back, I lost my job as an automotive serviceman and took a job as a process worker on about $10 less per week but with a lot less stress. But the cost of sophisticated equipment has dropped and the reliability has increased considerably in recent years. Maybe if people had to purchase new equipment every time something failed, they would think differently — but then again, maybe not.

Thanks for your comments too, Mr Hutchings. I guess you're right, that automotive service technicians have much the same problem. Yet as you say, electricians seem to fare a little better — and plumbers seem to do very nicely, it seems. Perhaps they've discovered how to sell themselves properly...

Detector safety

Moving on, you may recall that in the March issue, we published a letter from Alan Elliott VK3AL, of South Melbourne on the subject of smoke detectors. In particular Mr Elliott pointed out that many of the popular detectors contain a small quantity of Americium 241, which is both radioactive and extremely toxic. Apparently only 0.03 of a microgram of this substance is regarded as the 'maximum permissible body burden' — a very tiny amount indeed.

Well, Mr Elliott's letter has obviously struck a chord with reader Frank Moran, of Tarragindi in Queensland. In effect Mr Moran continues the discussion of these detectors, by raising the subject of how they are to be disposed of when

they fail. Clearly as they contain such a dangerous substance they shouldn't be simply thrown away in the rubbish. Yet disposing of them properly may not be easy, as he relates:

The letter from Alan Elliott, Sth Melb (EA March 1996), re the use of radioactive Americium in household smoke detectors, reminded me of an incident which happened to me about two years ago. But my story relates to the disposal of defective smoke detectors.

An elderly widow friend for whom I have renewed batteries in her two detectors in the past, asked me to look at one of her installations which had obviously developed a defect. It could not be silenced, no matter what I did to it — not that there is a lot one can do to such things.

I recommended that we replace it for her, and she agreed. From that point on the episode became what could be described as a 'comedy of ignorance', if it had not been so serious. I had to dispose of the little brute.

All detectors bear a warning that the unit contains radioactive material, and should be disposed of responsibly, by contacting a Health Authority.

I started with our city council, and explained my concerns to the switchboard operator — who put me on hold while she checked with the council health department, and the garbage disposal department. The advice was that I should throw it in my garbage bin.

When I explained that the 'thing' was radioactive, and was accompanied by a warning sticker advising against such action, she replied that she could not give me further advice.

Since local fire fighting units around the country strongly advocate the installation of detectors, I phoned the local station, where I was told that firemen have not been trained in the disposal of such things, and they could be of no assistance.

I searched through the telephone white pages and found a number for Disposal of Dangerous Goods. I was answered by a recorded voice which told me if I lived in Cairns (I live in Brisbane) I should press button 1; if I lived in Townsville I should press button 2; and so on until the the announcement had covered about half the coast of Queensland, by which time I lost patience.

Delving deeper into the white pages, the words RADIATION HEALTH caught my eye, and that entry told me to 'see Health, Q'land Department of'. At last I had found it, Director Radiation Health. An understanding male voice asked for my home address, so a car could call to take delivery of the detector.

If a government department considers it important enough to dispatch a vehicle for pickup, surely it must be just as important to ensure that all appropriate services, and every citizen, knows the procedure and is made aware of the seriousness of not disposing in the proper manner.

It does not need the brain of a genius to appreciate that a substance having a half-life measured in hundreds of years, should not be just tossed on a public garbage dump, especially in a decade or two when thousands of these things will have been discarded.

Incidentally, the Health Department dismantles the alarms, and the offending radioactive parts are locked away in safe storage.

Sadly, I have made approaches to a newspaper and a TV channel to publicise this information, without anything being done to my knowledge.

What more needs to be done?

Perhaps there's not much more that you can do yourself, Frank. You certainly seem to have done the right thing so far, even though it turned out to be rather harder than expected.

I agree that it's quite a worry that the various departments of your city council didn't seem to know what had to be done, and that the fire department didn't seem to know either. It certainly sounds as if the Radiation Health Department should be doing more education of the local authorities, doesn't it?

Quite apart from this, I'm also inclined to wonder about the cost of having the Department of Radiation Health collect old smoke detectors, dismantle them and store the radiactive Americium. This must inevitably cost a significant amount, which presumably comes from the public purse.

I wonder if the firms distributing and selling these smoke detectors contribute to the cost of this disposal? It seems unlikely, considering the low prices some of them are selling for...

Dangerous detector?

Moving on again, but still in the general area of detectors, I've had a letter in my Forum file for some months now, waiting for an opportunity to present it. It comes from Mr Steve Archer, a young reader from Ashburton in Victoria, and it's about passive IR detectors:

I was recently given a broken passive infrared detector that was originally part of a security system. As I opened it to see if it could be fixed, I was concerned by the lack of workmanship, especially on the detector board. As a 15 year old electronics enthusiast, I understand that this standard may be acceptable in low voltage equipment, but in a device which runs on 240 volts and delivers 240 volts at its output I feel it is dangerous and a potential fire hazard.

There are no markings on the case, except for 'Security Force', a specifications label, and a quality control 'pass' sticker. The blue and brown wires are the 240 volts in, and the black and white wires are 240 volts out (for connection to the flood lamps). This device is made in China, and appears to be hand made.

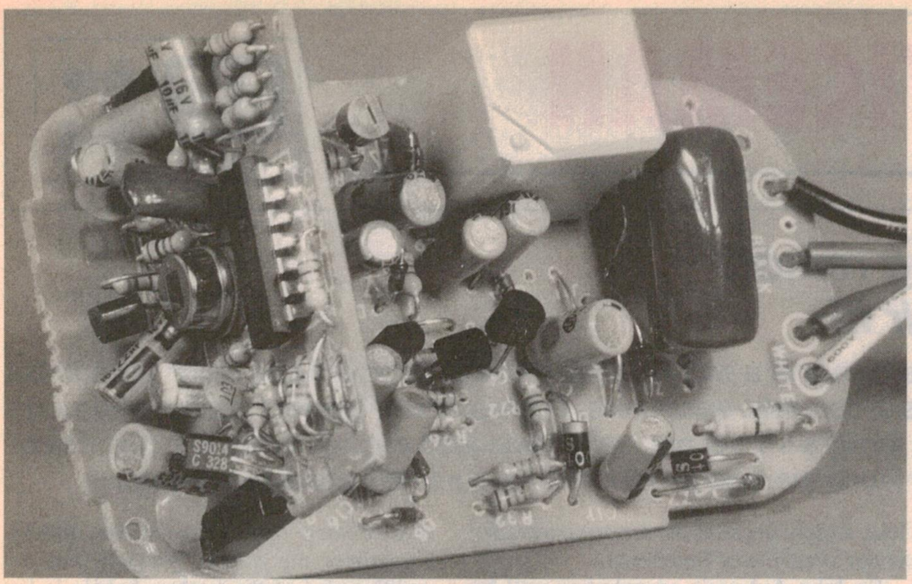
There must be hundreds of these devices installed in houses, and who knows how many other types of mains equipment of a similar standard. Do you agree with my concerns on this matter?

Along with this letter, Steve Archer sent the internals of the detector concerned, for us to examine. I took a photo of the board assembly, which is reproduced here to give you an idea of what he is talking about. As you can see it consists of two PC boards, a small board with the IR sensor device mounted at the centre, sitting vertically near the front of the larger main board.

Frankly, I'd have to agree with Steve Archer that the boards are pretty roughly designed, and crudely assembled. As Mr Archer says, the build quality on the detector board is very poor, with many of the components jumbled together at all kinds of weird and apparently random angles — many of them quite free to move around physically. Of particular concern is the lack of any real protection around the PCB tracks on the back of the main board, carrying 240V. I suppose the complete circuit is normally inside an insulating plastic case, but it still looks pretty scary.

It's hard to imagine how a passive IR detector, designed to be part of a security system, could have passed the appropriate safety and reliability checks to be imported and sold in Australia, with this level of poor quality.

Thanks for bringing this matter to our attention, Mr Archer, and I'm sorry it's taken a while before I was able to fit it in. Better late than never, though, I hope!



Here's a photo of the PCB assembly sent in by reader Steve Archer, and taken from a passive IR sensor used in a security system. As he suggests, the design and build quality leave quite a lot to be desired — especially as those wires on the right, and some of the PCB tracks, normally carry 240V at a couple of amps.

EMFs and cancer

And finally, this month, there's a letter that came from Mr Ken Hicks, of Inverell in NSW. Mr Hicks is mainly concerned about some of the recent comments made about the possible link between electromagnetic fields and cancer, as you can see:

In the June issue of EA, in his 'defence of the Internet', Tom Moffat described how he researched an article dealing with EMFs and cancer very thoroughly. This is such an emotional issue, that it would be good to see the arguments for and against set forth, together with any solid evidence that may exist. Perhaps the article could be published in EA?

In her letter in the same issue of EA, Betty Venables dismisses the remark 'not proven' as 'trite', and seems to be claiming that 'anecdotal evidence that 'artificial EMFs from all sources are biological stressors' can be accepted.

The reliability of anecdotal evidence is extremely shaky at the best of times, and when it comes within the biological field you have to deal with the great variability of response. A given stress does not always produce the same strain. For example, consider the amount of some toxic drug required to cause death. It is usually quoted as the MLD50. That is to say, it is the minimum lethal dose required to cause death in 50% of animals.

This variability is everywhere evident: not all smokers will get lung cancer; only a small proportion of asbestos workers will get pulmonary mesiothelioma; a few gold miners will get silicosis; a percentage only of sunbathers will get solar hyperkeratoses which will progress to skin cancer, and a very small proportion will get melanoma.

The proportion of people who will succumb to these diseases is relatively small, but it is constant. Of every thousand smokers smoking the same number of cigarettes per day, one can predict with a high degree of certainty how many will develop lung cancer within a certain time. Although the predicted number may be reasonably constant, it is much more difficult to predict whether any particular individual will suffer. (The cigarette companies know this!) There is always a wide individual variability which is now known to be at least partly genetic.

If your father and grandfather both smoked heavily all their lives and lived to be 90, you might be safe. But if your father or uncle died at 50 with cigarette-related lung cancer, you must have a very strong death wish if you smoke.

Similar arguments can be applied to exposure to asbestos, solar radiation, X-radation and numerous other physical and chemical stressors. There is plenty of statistical evidence. But is there a single shred of real evidence that RF radiation carries the same risk? Or any risk?

If RF radiation causes cancer, it should be extremely easy to produce evidence by an epidemiological study of the distribution of cancers of various kinds of people living near a broadcast or TV station antenna. Maybe even hams with their 1kW linears are digging their own graves or damaging their families.

We who live in a 'developed' country are constantly permeated by a wide range of RF frequencies. Switch on any small relatively insensitive transistor radio and you will be able to pick up any number of stations — some MW stations, some VHF stations, some UHF stations, to say nothing of several TV stations all pouring out their radiations. Is the cancer incidence from this radiation higher in the cities, where there are more stations, than in the bush where they are fewer?

Is the incidence of cancer in 'developed' countries, well-saturated with RF, significantly higher than in 'undeveloped' countries? Do people in these countries live longer, have fewer birth defects and less neo-natal morbidity? On the contrary.

In passing, I should question your concern (mentioned in your editorial for September, 1995) for the poor fellow in the police radio van who lost a testicle to cancer because he was sitting above a vertical-pointing antenna. Presumably this was a 1/4-wave vertical or something similar, and since the radiation pattern of such an antenna is quite low-angle and non-directional, wouldn't the safest place to be directly over the end?

I leave you with a comment attributed to the true believers in UFOs, that 'absence of evidence is not evidence of absence'...

Thanks for those comments, Mr Hicks, and I for one found them quite interesting. By the way, we've already published Tom's article exploring the evidence for a link between EMFs and cancer; it was in the February issue. Perhaps you missed it. I appreciate the points you make about the high variability which complicates any attempt to determine cause-and-effect involving biological organisms like ourselves. Your final point about absence of evidence not implying evidence of absence is also a good one, I agree — and surely it lends weight to my proposition that it's very unwise to dismiss a possible link between EMFs and cancer.

With regard to the unfortunate police officer sitting over the antenna in the surveillance van, it's possible that the antenna *was* a 1/4 wave vertical. But with the antenna apparently radiating virtually all of its output within the metal van (a crazy and most unwise situation, surely), I think it would be quite unrealistic to expect the antenna to exhibit a 'textbook' radiation pattern.

Frankly, I believe it would be an extremely foolhardy 'expert' who would want to deny that the officer's cancer had any connection with his exposure to the RF from that antenna. Don't you? ❖

THE SERVICEMAN

Don't throw that ailing remote control away — repair it!

One of our stories this month gives details of a way to repair remote controls, those much abused but increasingly important components of domestic electronics. There's also a tale from reader who works in the industry, but admits that his family's TV set gradually developed enough faults to make it virtually unwatchable, before he finally found the time to repair it. I'm sure he's not alone, though...

Our first contributor this month has a story that is more of a Service Tip than the usual servicing story. It comes from John Aylmer, of Chelmer in Queensland.

In recent years we have seen more and more essential functions transferred from the front panel of TVs and VCRs to the now universal remote control. Where once you could perform most operations from the TV itself, today it is rare to find more than the power switch available as a user control.

That might be a bit of an exaggeration, but not much. Even the fine tuning facility has been transferred to the remote control in many of the latest sets.

All of which begs the question — what happens if (a) the controller's battery goes flat; (b) you accidentally tread on the controller; (c) you lose the controller down the back of the sofa; or (d) the controller itself breaks down or fails for any reason. There are any number of reasons why your TV or VCR could become useless, simply because the remote controller is not available or functional.

So John Aylmer's contribution will be invaluable to readers of this column, be they servicemen or just responsible owners. Here's what he has to say...

Fire panels, burglar alarms, TV and VCR remote controllers all have a common failure point — the carbon conductive paint that is applied to the back of each pushbutton.

After a few years this coating wears, and the user notices that the key has to be pressed harder and longer than usual to make it work. If the remote is dismantled and the rubber contact pads carefully cleaned, it sometimes improves the operation. But it's not a total cure, as some of the carbon paint is removed with each cleaning.

If fluids like soft drinks have been spilt into the remote, it totally removes the conductive paint and the unit is a writeoff. Most controllers in this condition are thrown away, but they can be repaired to as-new condition by re-coating the rubber pads with silver conductive paint.

This product is available from Electrolube and is coded SCP03B. Although it is in a very small container, it contains enough material to recoat dozens of keypads.

Originally, I had fears that the paint may flake or chip off the rubber, so I coated a worn burglar alarm keypad with the paint, reassembled the keyboard then continuously pounded the keys for an hour or more. Afterwards, I could see no deterioration in the coating and have since repaired many controllers with this paint, with no problems whatsoever.

As replacement remote controllers cost between 50 and 200 dollars, the originals are generally worth repairing if at all possible. To restore a worn or inoperative remote controller to as new condition, I proceed as follows...

I dismantle the remote, clean the battery contacts and retension the springs. Sometimes the dimple pressed into the positive end of the battery holder is not large enough and the shoulders of the battery hit the plastic moulding before the positive terminal reliably touches the contact. To correct this, I remove the tinplate terminal and bend it forward to increase the size of the dimple.

Check the ceramic resonator, since the leads often break off at the body of the component. Glue the resonator to the PCB, if this has not already been done. Check all solder joints for fractures, especially at the output LEDs.

Remove the rubber keypad mat and clean the contact side. Coat each keypad bumper with silver conductive paint, taking care not to get the paint on the mat outside the bumper area. DO NOT APPLY ANY PAINT TO THE PCB, EITHER DELIBERATELY OR ACCIDENTALLY!

The silver conductive paint can be applied with a matchstick or a small brush. Some acrylic thinners will be needed to wash the brush, and also to top up the paint container to prevent the paint from thickening. Once painted, wait 30 minutes for the paint to dry, or help it along with gentle heat from a hair dryer.

If the remote still does not function, look for cracks in the PCB copper tracks. Occasionally, the LED or the driver transistor fails, as does the ceramic resonator. The main chip rarely fails, but surface mounted types sometimes have faulty solder joints.

As an absolutely last resort, try applying an iron to any plated-through holes in the PCB. This sometimes fixes the problem, but it is a drastic measure which can create troubles of its own, especially where non-metallic tracks are used.

These last comments might suggest that remote controls suffer from varied and difficult faults. Not so. The majority can be fixed by repairing the battery contacts

and recoating the key pad bumpers.

Thanks for those tips, John. Remote controllers are as common as TVs and VCRs, but they lead a very hard life. As you say, they break down just as often as their companion appliances and the list of suggestions in your contribution will be of great benefit to anyone faced with a baulky remote.

There's just one further comment I'd like to make. With some remote controllers, the conductive paint is so loosely attached that no cleaning of any kind is possible. I have found that new buttons are usually available for these kinds of controllers, but they are expensive and there's the problem of placing an order and waiting for delivery.

John's suggestion about using conductive paint to replace the missing contact surface is a great idea, that will probably save the lives of hundreds of sick remotes.

The plumber's taps...

Our next story comes from John Walsh, of North Ryde in NSW. As his address might suggest, John is employed in our version of Silicon Valley and like so many workers in electronics, he would rather not pick up a soldering iron between 5pm and 8am. However, as John reminds us, there comes a time...

I've often wondered if the mechanic's car is the last to get regular maintenance. Or the bootmaker's kids really do go barefooted to school, as urban mythology claims!

Whether or not those stories are true, there is an authenticated similarity in this saga of the decline and fall of the family colour TV set, under careful and considered supervision in the home of an electronics engineer. It's very easy to put off doing anything, while ever there is a reasonable chance of restoring normality with a solid thump to the cabinet. The need to do anything at all can be continually reduced until finally, it demands attention from the sheer inconvenience of the multiple faults that develop as time rolls on.

But enough philosophy. (Thankfully! I was beginning to lose the thread. Ed.) *My tale relates the family's Sharp CX2082, which has put in good service for more than a decade. The only previous failure had been the line output transformer some years back.*

There had more recently been a slow deterioration in performance over a number of years, but 'work-arounds' (or methods of avoiding real action) were devised for the symptoms which kept matters under control.

The first was the set failing to turn on fully with picture and sound when operated from a cold startup, whether using the remote control or the front panel power switch. Through the process of trial and error, this problem could be overcome by cycling the control to off and then on again after a small delay. This had also a side benefit of being a room temperature indicator!

The on and off sequencing had to be repeated a number of times, in proportion to the room temperature with the change of seasons. (This might give some indication of the time that the fault was tolerated, before some real action took place)

All was well, with the work-arounds firmly in place to accommodate the symptoms so far. But then a new problem showed up. Retrace lines appeared at the top of the screen from a cold power up. But this too could be overlooked, because it disappeared as the set reached operating temperature.

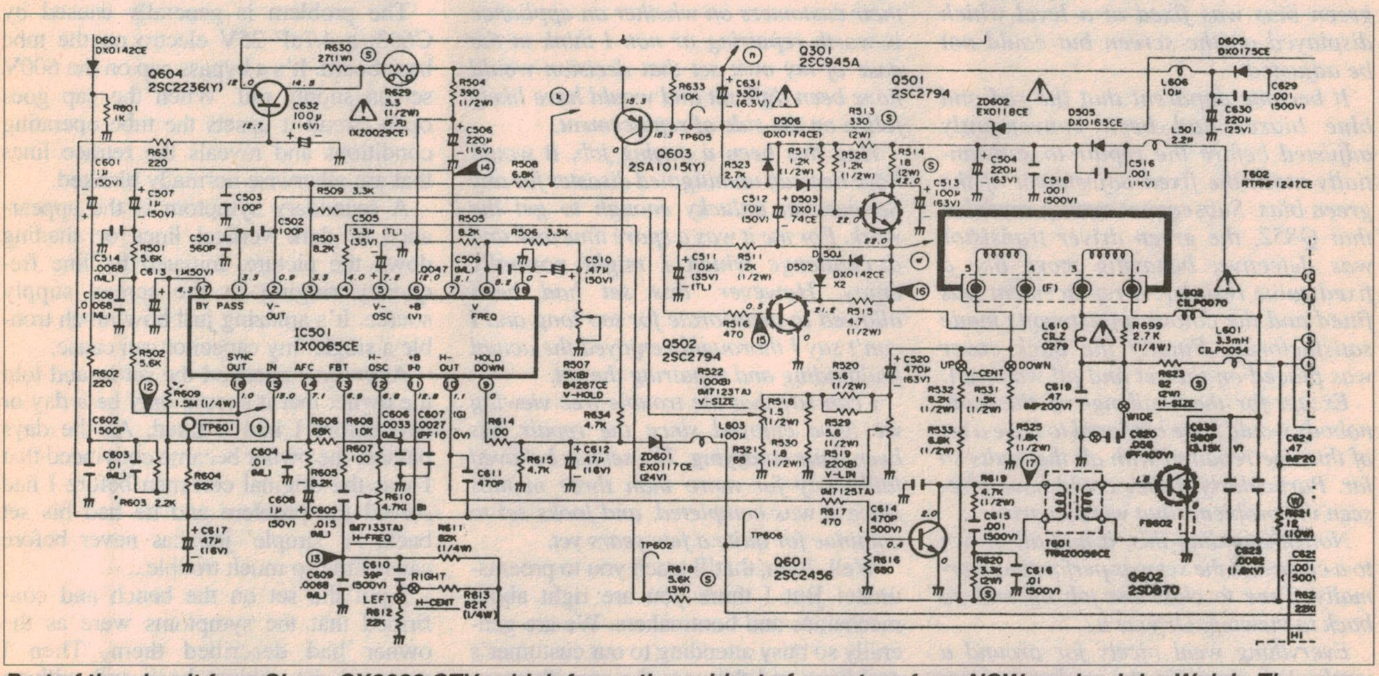
All it took was a little patience (and a little more, and more as time rolled on). Everything good comes to those who wait. To be fair however, the on/off cycles and warm up times were slowly growing in length. The time for doing something was approaching.

Drawing on my training and experience with measurement electronics, and being a long time reader of the Serviceman, some clues and fault analysis had already been taken onboard from various earlier case studies.

Looking for temperature sensitive components with the freezing and heating techniques had been a failure. The turn-on fault only ever appeared in the first few seconds from turn-on anyway. So better to start on the more permanent faults.

From past reading of the Serviceman, the likely culprits were dried-out electrolytic capacitors in the main functional areas that were giving trouble.

The retrace blanking was a good starting point. Tracking through the circuit, beginning from IC801 pin 2 the BLANKING IN input of the video processor chip, the signal path was traced back towards



Part of the circuit for a Sharp CX2082 CTV, which forms the subject of our story from NSW reader John Walsh. The symptoms were unreliable starting from cold, and bright retrace lines visible at the top of the screen. The causes were all in this part of the circuit....

the sync separator IC501.

After removing a few capacitors in the signal path and measurement of capacitance values, a likely culprit was found in a 10uF 35V cap C511 — which measured more like 2uF. The capacitor was replaced and the retrace blanking problem solved.

The job was proceeding in an orderly fashion, so far. One problem solved, now to check out the switch-on problem...

The set has overload and shutdown circuitry to stop the horizontal oscillator in the event that a fault occurs. Reading the circuit operation notes in the manual and looking at the circuit diagram, the protection was triggered by an SCR built into the sync separator IC501, which had at its gate the HOLD DOWN input.

Again a check of capacitors on the signal line to this pin revealed that C612, a 47uF 16V capacitor, had no measurable capacitance. This was replaced and the switch-on problem seemed to be solved. I say 'seemed to be' as more was to unfold as time went on...

It was time to close up the cabinet and complete the job. One last problem after reconnecting all the PCB plugs and connectors was the colour bias pots on the picture tube socket PCB. These had been moved off position with all the activities during testing.

A pattern generator was applied and adjustments attempted, only to find the green bias was fixed at a level which displayed on the screen but could not be adjusted.

It became apparent that the red and blue biases had been conveniently adjusted before the repair to substantially mask the fixed adjustment of the green bias. Subsequent testing revealed that Q852, the green driver transistor was defective, behaving more like a fixed value resistor. A replacement was fitted and the colour adjustments made satisfactorily. Finally the back cover was placed on the set and all was well.

Except for the challenge of the hunt, nobody would have bothered to have a set of this age repaired with all the faults so far. Particularly if they could have foreseen the problems that were to arise.

Notwithstanding this, it had all drawn to a close and the set was performing normally. Time to close the job off and go back to viewing. Or was it?

Everything went nicely for around a week when one night, the set dropped into the over-voltage or overload trip mode for no obvious reason, after it had been working normally for several hours.

By now alarm bells were ringing. Was it really worth continuing with the repairs, pouring in more time and effort? Or better to face the inevitable prospect of replacing the set? Maybe one last attempt would be worthwhile.

Back to the area around replaced capacitor C511, to see if anything further could be found around the IC501 HOLD DOWN input connection. Just in case there had been too much haste in soldering in the replacement for C511, the solder joints were scrutinised.

Careful investigation of the solder joints on the capacitor produced the conclusion that my soldering skills had not failed as at first thought possible. However during this close visual check with a jeweller's loupe, an almost imperceptible dry joint was found on a resistor immediately adjacent to C511. The joint was resoldered and the set checked out.

Although the capacitor on the HOLD DOWN line had been faulty, causing the original turn-on failure, the subsequent in service failure was caused by the dry joint on the resistor — which had been both aggravated and temporarily repaired by the removal, installation and flexing of the main PCB.

In retrospect, one should question whether the same path would have been taken. This also reinforces the difficulties experienced by servicemen in advising their customers on whether an appliance is worth repairing or not. I think in the case of my own set that decision would have been difficult and would have likely fallen on the side of replacement.

Had this been a paying job, it would have been an unmitigated disaster for any Serviceman unlucky enough to get the work. For me it was a spare time task and a challenge which I might normally enjoy. However, this set had been allowed to deteriorate for too long and I can't say I thoroughly enjoyed the actual faultfinding and repairing the set.

I can say that the trouble-free viewing we have enjoyed since the repair has been quite satisfying. The set has behaved faultlessly for more than three months since it was completed, and looks set to continue for quite a few years yet.

Well, John, that'll teach you to procrastinate! But I think you are right about mechanics and bootmakers. We are generally so busy attending to our customer's problems and they are the ones that pay the bills. Repairing our own equipment (cars? boots?) does not put jam on the table, and so gets pushed to the back of the bench every time.

Though I must say, there is one thing to be said in favour of putting off what should be done today. Many faults are much easier to find if they have deteriorated to the state of 'nearly unwatchable'.

Anyway, John, thanks for your story. Don't forget that we would be interested to hear of some of the maintenance and repair problems you find in Australia's 'Silicon Valley'.

Now for a story from my own bench.

'Simple job' wasn't!

In all the years that I have been writing this column, I have only once come across a story that involved a resistor going low in value. In every other case, resistors have gone high or open. But now I have come across another example, and it's a story that caused me no end of angst before I got it sorted out.

It came about this way...

The Sanyo 7605 was a fairly early model, with a 75P chassis in a lowboy style cabinet. The owner brought it in with the complaint that it had an over-bright picture with white 'venetian blinds' covering the screen.

Over the years I must have had at least 760 Sanyo 75P's with these venetian blinds. Well, if not quite 760, then still an awful lot since the fault is one of the most common associated with that chassis.

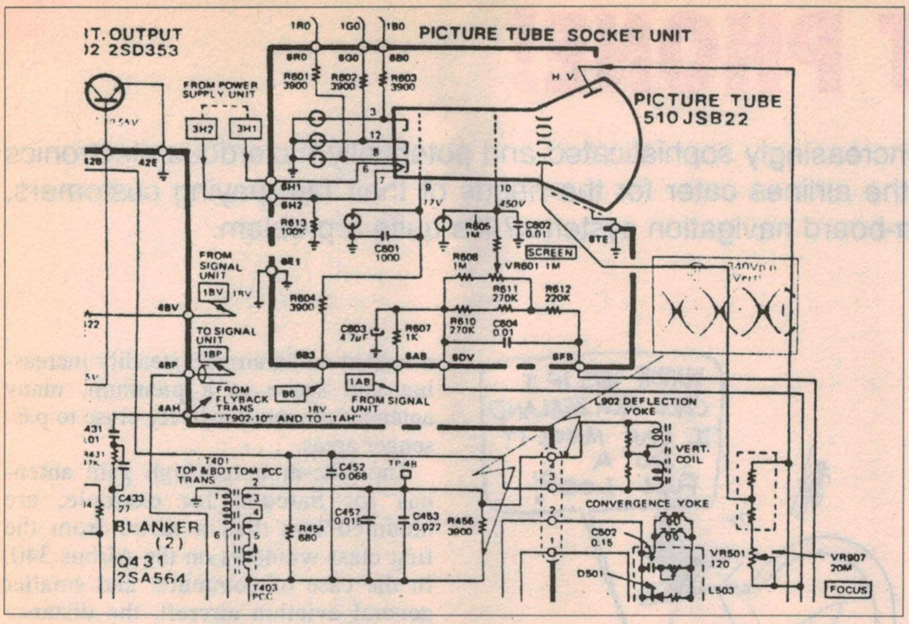
The problem is generally caused by C603, a 4.7uF 25V electro on the tube base board. It's a bypass cap on the 600V screen supply rail. When the cap goes open circuit it upsets the tube operating conditions and reveals the retrace lines that are otherwise normally blanked.

A secondary symptom is the appearance of dark vertical lines or shading down the picture, initiated by line frequency ringing in the screen supply source. It's amazing just how much trouble a single tiny capacitor can cause.

Anyway, I checked the set in and told the owner that it should only be a day or two before I had it fixed. As the days passed, the owner became convinced that I was the original con man before I had solved the problem and he had his set back. A 'simple' job has never before caused me so much trouble...

I put the set on the bench and confirmed that the symptoms were as the owner had described them. Then I removed the cabinet back and without even checking any voltages, immediately replaced C603. These tiny electros are

When the Sanyo 7605 came in with 'white venetian blinds' covering the screen, our serviceman thought he knew what the cause would be, and expected it to be a simple repair job. It wasn't — but the cause did turn out to be in this area of the circuit, as he expected...



notorious for going open circuit or drying out to a low value, so I keep a good stock on hand. I didn't even bother to test the old one, so confident was I that it was the cause of all the trouble.

So, after turning the set back on and waiting for the picture to come up, I was appalled to see the retrace lines still present, in all their brilliant detail. This sent me back to square one, in this case to the filing cabinet where I keep all the service manuals.

The Sanyo 75P chassis screen supply circuits are a bit different to most other sets, even in the Sanyo range itself. The supply is taken off the bottom of the EHT winding and passed through a series-parallel network, on its way to the Automatic Beam Limiter circuit in the video amplifier chain on the Signals Board. Sounds complicated? Well, it is! Far more than other Sanyos.

Since one of the symptoms was an overbright picture, I had to investigate conditions around the ABL circuit and the video amplifier. This includes a transistor and a 100uF electro, a couple of trimpots and several critical resistors. Checking out this conglomeration took an hour or more, but revealed nothing untoward. The picture remained just as it was when the set came in.

I had to put the set aside and get on with some other work. But at every spare moment, I returned to the circuit diagram and tried to work out where I would go next. I selected two sections that warranted further investigation.

One was the video blanking circuits, involving transistors Q431 and Q432, and the other was the 180V supply rail to the video output transistors.

The first of the blanking transistors, Q431, was a 2SA564 and I have had a lot of trouble with older types of PNP transistors. They always seem more prone to breakdown than their NPN counterparts. But in this case, changing the transistor for a brand new replacement did nothing to restore the set to normality.

When I turned to the 180V rail, I found another likely cause of trouble: C287, a 1uF 250V electro. Regular readers will be sick and tired of hearing me say this, but low value electros, especially high voltage types, are notorious for breaking down. I usually replace them as a matter of course but that procedure in this case was a waste of time. The old capacitor was in perfect condition!

By this time the set had been on the bench for about 10 days, and the owner had rung several times to see when he might have it back. I could only apologise for the delay and promise to call him as soon as I had found the fault.

Eventually I had been all over every part of the set that could conceivably cause the symptoms. I haven't mentioned the power supply, but I had been all over that circuit, looking for wrong voltages or ineffective filtering.

I had checked the video path from the detector to the tube base and could find no trace of a wrong voltage or bad signal. In short, the set was as perfect as one could wish for, except that it had these distressing retrace lines on an overbright picture.

In desperation, I tried reducing the brightness with the front panel brightness control and with the internal sub-brightness trimpot. These were effective in bringing down the overall screen illumination, but did nothing to reduce the level of retrace lines.

Finally, there was only one thing left to try — the screen control on the picture tube base board. And this produced an immediate and totally effective cure. First the dark bands disappeared, then the retrace lines, and at last I had a perfect picture.

I turned the screen pot up again and the lines returned. There was no doubt about it, but the cause of all the trouble had been the screen voltage. There was ample adjustment available with the pot to cover the range from overbright to almost cut-off, so it didn't seem as though there was a faulty part involved. All I could put it down to was component drift.

When I looked at the screen supply, I was drawn to the series parallel network on the tube base board. It comprises R608, R610 and R604, R612 and VR601. I did a bit of simple maths on the values of these resistors and arrived at a total of 577,142 ohms between terminals 6DV and 6FB on the base board.

When I checked the value on the board, the best result I could get was around 450k, more than 100k less than it should be. At first, the only reason that I could see was that one of the resistors had gone low in value. I had spent so much time on this job that I wasn't prepared to spend much more investigating a problem that didn't need investigation.

(Continued on page 101)

HOLD THAT PHONE!

Airline passengers are bringing increasingly sophisticated and potentially hazardous electronics on board aeroplanes. How can the airlines cater for the needs of their fare-paying customers, without upsetting the sensitive on-board navigation systems? It's quite a problem.

by ROD PASCOE

In the mid 1980s, those airline passengers who were paying attention to the preflight briefings may have noticed a change in the patter. As the well-rehearsed flight attendants were directing karate chops towards the front, rear and over-wing exits and performing Christopher Skase impersonations with the oxygen mask, a new line was added to the PA announcement: 'Passengers are not to use any electronic devices such as computers or electronic toys during climb or descent, and mobile phones are not permitted to be used at any time as they may interfere with the aircraft navigation systems.'

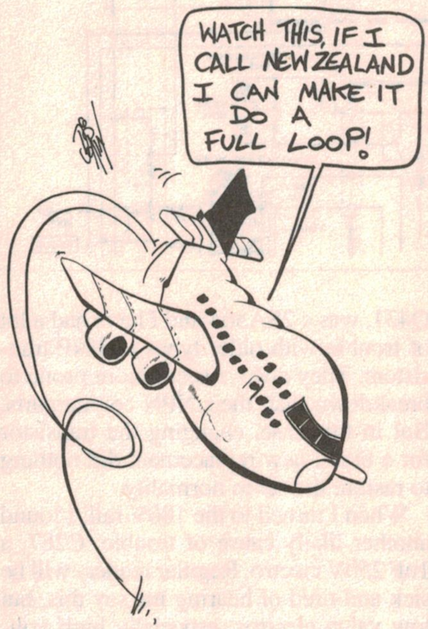
At the time, this cynical writer thought that the airlines were trying to scare us with this safety lecture, when in fact they were just waiting for the technology to install satellite pay phones in the armrests and then charge us for the privilege. As it turned out, I was right about the airborne satellite phones, but wrong about the safety aspects.

In fact, electromagnetic interference from portable electronic devices (EMI from PEDs) has been reported by many airlines as effecting some navigation systems.

But what is the possibility of a PED radiating on a navigation frequency? First, the range of frequencies used by radio navigation systems is broad, starting with 10.2kHz and extending to almost 10GHz (see Table 1). In addition, there are virtually thousands of frequencies used for aircraft radio systems spread throughout this range.

PEDs, on the other hand, can radiate a broad spectrum of frequencies. High performance laptop computers, for example, with their ever-increasing clock frequencies can radiate up to several gigahertz. With the broad range of radiated spectrum and the broad range of frequencies used by radio navigation, the possibility of radiated energy from a PED falling on a radio navigation frequency is high.

It must be remembered that seemingly 'passive' devices, like computer games and radio receivers have oscillators in them which can also radiate or transmit energy.



How susceptible?

So just how susceptible are radio navigation systems to interference? The amount of interference depends on the type of interfering signal, its proximity to the navaid frequency and the amount of energy being radiated. It must be also remembered that it is not only the fundamental frequency which may be a problem, but a harmonic of that frequency.

Fundamentals and harmonics are easily demonstrated by driving your car close to a Non-Directional Beacon (NDB) transmitter found at most airports, and tuning your car radio to twice the NDB signal frequency (which is found in most airband monitoring or scanning publications).

Let's say the NDB is transmitting on 415kHz. By tuning your car radio to 830 on the AM band (twice the fundamental frequency), you can listen to the NDB broadcast. Your car radio receives the second harmonic (830kHz) of the NDB's fundamental (415kHz).

Antenna location is another factor that affects the potential for interference. Most antennas are mounted in the centre of the fuselage or high on the vertical stabiliser. With the number of antennas mounted on an aircraft steadily increasing and space at a premium, many antennas are mounted very close to passenger areas.

The side-mounted high gain antennas for Satcom, for example, are mounted less than a metre from the first class windows on the Airbus 340. In the case of commuter and smaller general aviation aircraft, the distance from a PED and an antenna of less than one metre is possible.

Airlines are reluctant to divulge details of PED interference, except to say it does happen and it is a problem. The problem has been around for at least 10 years. So what's the solution? Do not permit passengers to operate portable electronics aboard aircraft during any phase of flight.

This solution, although risk free, is the least popular. At the moment the industry practice is to ban PEDs during take-off and landing, which is a compromise. There are, however, sporadic reports of interference to enroute radio navigation from PEDs.

Compass deflection

Since 1994, there have been 25 reported cases of PEDs creating problems with aircraft systems in Australia. The following are three of the reports made to the Bureau of Air Safety Investigation after interference from passenger/portable devices was suspected.

'The aircraft was at FL370 (37,000 feet) with autopilot B engaged. The aircraft was found to have strayed 0.7 nautical miles left of track, after a track check was made. Enquiries revealed a laptop computer in use in the cabin. Track deviation stopped when the computer was turned off.'

'The aircraft was cleared direct to Katoomba after take off. The information was entered in Omega 1 and checked OK. However the track did not match the Automatic Direction Finder (ADF) bearing. The wind page (on the flight management computer) was checked and found to be indicating 200 knots, which was not possible. Omega 2 was giving correct indications so it was used with the ADF for tracking. It was later learned that

a passenger in row 26 had been using a video camera during and after take off.'

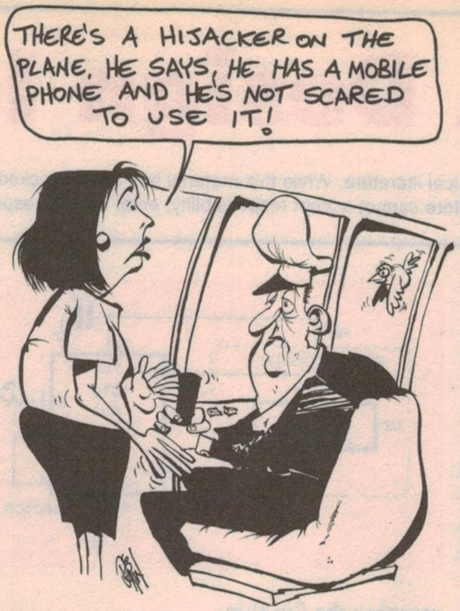
'The pilot reported interference to the aircraft's electronic system during descent from FL350 to FL310 (35,000 to 31,000 feet). Investigations revealed that a passenger had attempted to use his cellular phone in flight. The phone caused the aural 'master caution' to sound. There were no other warnings evident.'

Among the 25 reported incidents, CD players, tape players, electronic games and personal organisers were also suspected culprits.

Finnair for one has been experimenting with mobile telephone detectors. The portable unit, which is designed to detect mobile telephone signals inside aircraft cabins, consists of a non-scanning radio receiver, which can be tuned to 'listen' to a variety of frequencies. It is most sensitive at around 900MHz, a frequency commonly used by cellular mobile telecommunications systems.

Unfortunately the unit was triggered several times by the aircraft's own avionics systems. At least this demonstrates how much RF is floating around an aircraft cabin. Finnair reported false alarms with the device at 400Hz, the alternating current frequency normally used for powering aircraft systems. When an external source loads this frequency, the aircraft will generate an interference field, possibly triggering the detector according to Co-Jot, who developed the device.

The aim of the Finnair trials is to establish how widespread the use of mobile telephones on board aircraft is and then to eliminate it. Use of personal telecommunication equipment on aircraft is forbidden under International Air Transport Association (IATA) and Finnish telecommunications rules, but Finnair reports passengers are still making calls. Cabin crew are guided by the detector's blinking LED and audible alarm, which increase in frequency and pitch as an active telephone is approached.



The unit's range is 50 metres. While the device will not detect telephones in passive mode (switched on, but not in use) it will pick them up whenever 'handshakes' with cellular base-stations are made. Incoming calls during a flight can also be a problem if mobile telephones are not turned off.

Sky phones

The introduction of satellite telephone systems on commercial flights is now a reality. Although an expensive alternative, this will at least start to alleviate some of the dilemma of passenger satisfaction versus safety.

Most long-haul airlines have fitted some sort of passenger communication facility in their fleet. Qantas plans to install telephones and fax machines on all 18 Boeing 747-400 aircraft by the end of 1997.

In the 747-400 aircraft, the telephones, which use the Inmarsat satellite for global communications, will be installed in all seats in conjunction with an interactive entertainment system. Additionally, there will be phones located on bulkheads throughout the aircraft to maximise conversational privacy, with two in each class and one on the upper deck. The aircraft's fax machine is centrally located and operated by cabin staff.

Airlines also know that they can make a lot more money from providing these facilities, particularly from their first and business class passengers. Many of these passengers spend much of their time in the air working away on portable computers. Increasingly, these passengers are seeking on-board facilities to communicate with the world below — facilities such as telephones, modem data connections and facsimile machines — especially when they're not allowed to use their own.

But using phone and fax services on aircraft isn't cheap: Cathay Pacific for instance are charging $11.62 a minute regardless of distance, and this is one of the best rates on offer in the sky. However, on-board phones and faxes can be extremely useful in certain circumstances, including changed travel schedules or just doing business — such as conveying decisions.

For the airline, Satcom equipment is not cheap. The Rockwell/Collins SAT-906, for example, sells for around $360,000 and another $126,000 for the antenna system. In some aircraft, Qantas' Boeing 747-400 fleet for example, this equipment is already fitted as part of its satellite based navigation and communication system known as FANS, or future air navigation system avionics package. In this case, offering one of the Satcoms voice channels for passenger phone and fax communication will help subsidise the airline's investment in the navigation side of the system.

However, airlines with the aircraft not fitted with the sophisticated FANS satellite equipment may well be pressured by their customers into installing satphone systems into their aircraft — with its associated heavy price tag and high user cost.

So there's the dilemma. The airline operations departments — the technical side of airline management — want to ban any and all passenger/portable electronic devices. On the other hand, the marketing departments — those responsible for putting bottoms on seats — do not want to inconvenience or restrict their customers. Particularly in the high-revenue first and business classes, the ones more likely to want mobiles and computers...

In the short term, a solution could be as simple as the flight attendants telling the pilots when passengers are using their toys. At least the pilots can be on guard for possible interference to their flying machines. ❖

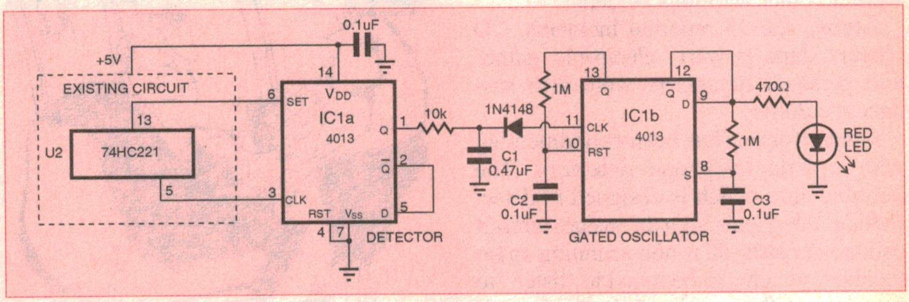
TABLE 1: Airborne Radio Systems

VLF Omega Navigation	10 - 14kHz
Loran-C Navigation	100kHz
Non Directional Beacons (NDB)	109kHz - 2MHz
HF communication	3 - 20MHz
Marker beacons	5MHz
VHF Omnidirectional Range (VOR)	108 - 118MHz
VHF communications	118 - 137MHz
Instrument Landing System (ILS)	329 - 335MHz
Distance Measuring Equipment (DME)	1000MHz
Tactical Air Navigation (TACAN)	960 - 1215MHz
Satellite navigation systems	1228- 1575MHz
Secondary Surveillance Radar (SSR)	1030- 1090MHz
Global Positioning System (GPS)	1.5GHz
Microwave Landing System (MLS)	5GHz

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide any further information.

Overrange indicator for 1MHz pulse generator



Having built the 1MHz Pulse Generator (June 92), I found that when I varied the pulse width, I had no indication that the generator was still within the set period of the clock frequency, when I used the unit as variable duty-cycle oscillator. If I inadvertently advanced the PW-control too far (near 100% duty), monostable 2 can't retrigger and the frequency halves abruptly. To eliminate this undesirable effect and for easy setup of the controls I designed this circuit, which flashes a LED when the pulse width exceeds the clock period.

This additional circuit is based on the dual D-Flipflop IC IC1. IC1a is wired as a detector, while IC1b is a gated oscillator. IC1a is connected to pins 13 and 5 of the dual mono U2 (74HC221) inside the generator. Its Q output is set by the rising edge of the U2's delay-pulse, causing IC1's Q output to go high and Q-bar low — which also takes its data input (pin 5) low as well.

The output of monostable U2b connects to the clock input of IC1a (pin 3). When this monostable output goes high, the low data is clocked through to its Q-bar output, resetting the flip flop.

This repeats at the oscillator's clock frequency, and the resulting waveform is a duplicate of the delay pulse. The Q output is integrated by R1 and C1, and the resulting voltage corresponds to the generator's duty cycle. As long as this voltage is less than 2V, the gated oscillator (IC1b) is disabled via the diode holding its reset pin low.

If the combined pulse width and delay output exceeds the clock period, IC1a is not able to reset via its clock-input, since the generator's monostable output is still high and remains high until it retriggers. This causes the voltage across C1 to rise, reverse-biasing the diode.

Now IC1b resets, and its Q-bar output goes high — lighting the LED and charging C3 via the 1M resistor; while Q goes low discharging C2. When the voltage across C3 exceeds 2.4V, IC1b is set, switching its Q-bar output low and Q high. C2 charges up again, the flip flop is reset and the process is repeated at approximately 7Hz, flashing the LED.

To ensure the circuit works properly, the delay-pulse must always be less than 50% of the clock period. The circuit is simple, costs next to nothing and is independent of the output polarity setting. Now you can use the pulse generator as a variable duty-cycle oscillator without the need to hook up an oscilloscope!

Manfred Schmidt,
Edgewater, WA **$40**

Twin joysticks from a sound card

Many PC manufacturers these days are providing only one joystick port, even though the 15-pin joystick port can easily accommodate two as originally intended. They then expect you to fork out another $50 or so to buy a card with two separate 15-pin joystick ports!

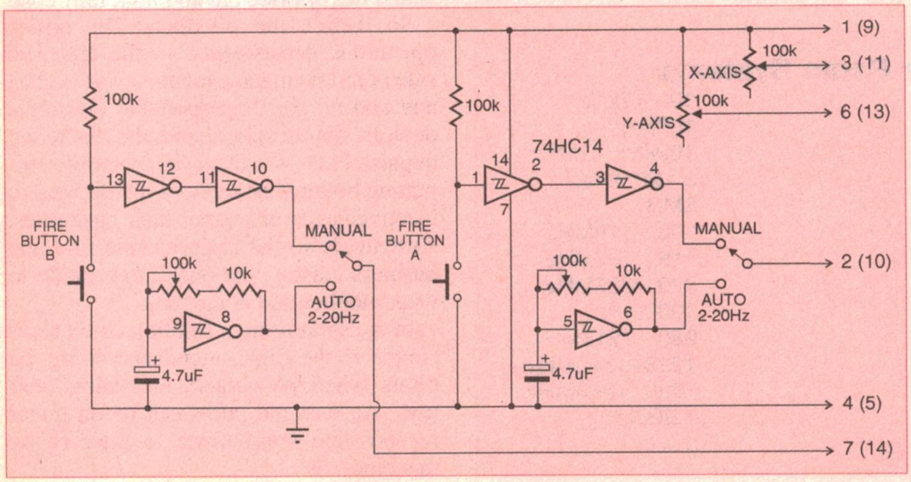
Increasingly though, sound cards such as Sound Blaster are becoming popular. These come equipped with a single 15-pin port with provision for two joysticks (as originally intended by IBM), but with the port also doubling as a MIDI interface connector. For this reason, two pins intended for the second joystick are reserved for the MIDI Out (12) and MIDI In (15) in lines.

In the original IBM specification, pin 15 is the second supply pin for the second joystick and is therefore superfluous, as is pin 12, which is the ground pin for the second joystick. Unfortunately this means that a standard Y-adapter cannot be used to connect a second joystick to a sound card, unless the ground path for the second joystick is routed through pins 4 or 5.

The following circuit for twin joysticks with debounced autofire facility was developed for a 486 system equipped with a Sound Blaster sound CD16 card. A Y-adapter is unnecessary, since both joysticks are wired into a single 15-pin D plug.

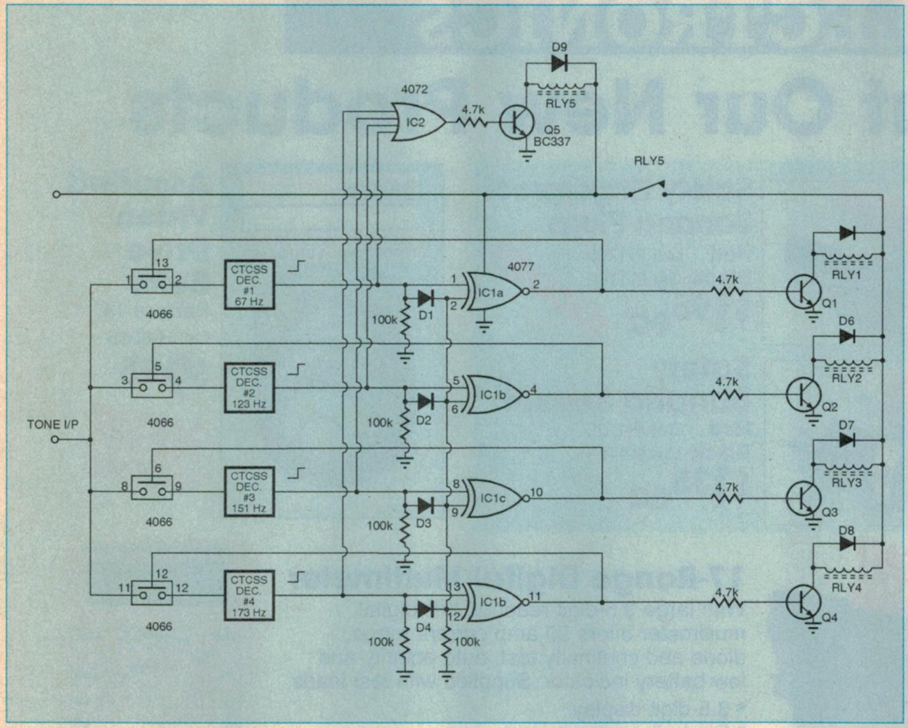
The circuit for joystick 1 is shown here; an identical circuit is used for joystick 2, which connects to the pin numbers in brackets.

S. Kamaldeen,
Hobart Tas. **$45**



CTCSS signal switching system

CTCSS stands for 'continuous tone coded squelch system', and it's a system used in the two-way radio industry to allow receivers to respond only to certain transmissions. Sub-audible tones are transmitted along with the signal, and the receiver listens for these tones (67Hz to 250.3Hz), switching when one is detected. This switching circuit is designed around four CTCSS modules, and activates one of four relays depending on the tone transmitted.



In its initial state, the circuit allows the signal to be received by all four modules. When there is no CTCSS tone present on the tone input line, the outputs of each of the 4077 exclusive NOR gates are high because of the two low signals on the inputs of each gate. Transistors Q1 to Q4 are thus biased on, switching 0V to the relay coils RLY1 to RLY4.

Each CTCSS decoder module gives an active high output if the input signal contains the module's specific frequency. If, for example decoder 2 (123Hz), senses a 123Hz tone in the signal, its DC output switches high. This high signal output appears at pin 5 of IC1b and also pin 6, via diode D2. Being an XOR gate, the output at pin 4 remains high, but the outputs of IC1a, IC1c and IC1d switch low due to the blocking action of diodes D1, D3 and D4. The quad bilateral switch on the inputs to the decoders switches accordingly, preventing any other tones from reaching the other decoders. When the 123Hz disappears from the transmission, the signal is switched back to all four decoder inputs.

IC2 biases on Q5 whenever there is an active output from the CTCSS decoders, thus supplying +12V to the relay coils RLY1 to RLY4 via RLY5's contacts.

Peter Howarth,
Gunnedah NSW **$35**

Port-Powered MIDI Interface for the Mac

MIDI interfaces for the Macintosh will set you back $100 or more in Australia. The ones Apple sell are not only pricey, but they only have one output as well. You can build one for yourself for a fraction of the price of a commercial unit (mine cost me about $30 including the box), and it doesn't even need a power supply! As well as being self powered, it has provision for three MIDI outputs, and could easily be expanded to four if you wanted.

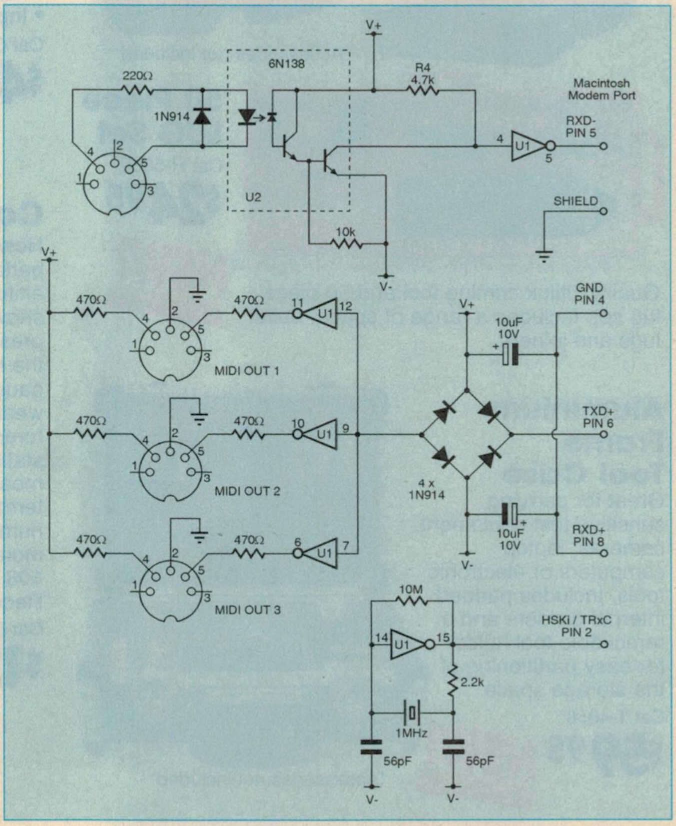
My Macintosh 280c generates about 6.7V between the V+ and V- points on the circuit, and the value of pullup resistor R4 needed to be quite high (4.7k) to make the interface work. If yours doesn't work reliably (which may be the case if you use it with a 100 series powerbook — I understand that these have trouble generating anywhere near that much power), then try varying the value of this resistor. Somewhere between 500Ω and 5k should work, but I would start at the high end and work down.

The circuit's operation is fairly straightforward, with the four small signal diodes and two 10uF capacitors creating a dual rail supply whenever the computer's modem port is active.

The 1MHz oscillator feeding into the Mac's HSKi/TRxC input sets the port speed of the Mac to the MIDI standard of 31.25kHz.

I used four PCB-mount MIDI sockets and a small piece of strip-board to build my interface, but there's no reason you couldn't do otherwise.

John Loadsman,
Stanmore NSW **$40** ❖

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Great for carrying sensitive test equipment, cameras, laptop computers or electronic tools. Includes padded internal dividers and a removable tool holder for easy partitioning of the storage space
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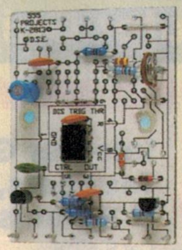
*Accessories not included

Useful Kits To Build

DISCOVERY SERIES

Multi 555 Timer Circuits

A general purpose IC that acts as a building block for timer projects. The 555 allows a timer or pulse generator to be quickly and cheaply put together with just a few parts. It is also capable of operating relays directly, and is easier to set up for those utility projects. Supply voltage range is 4.5V to 16V. Supplied with all components & a silk screened, solder masked PCBs, and a comprehensive instruction manual showing many circuits & overlays for different timing configurations. No power supply or box are supplied with the kit.



Cat K-2813

$16.95 EA Aug '96

Electronic Fluoro Starter

For rapid turn-on and blink-free running of your fluoro lamps, this is the kit. It fits in a standard starter case so the lamp wiring does not have to be altered. Kit is supplied with all specified components, PCBs, and starter case.

Due late August

Cat K-3012

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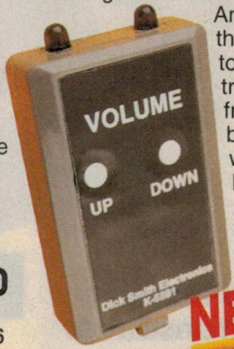
SILICON CHIP Aug '96

Infrared Volume Controller

Controlling the volume on your K-5591 50W Amp kit is a breeze with this usefull and easily put together kit. The transmitter is powered from a single A3 12V battery. Kit is supplied with all components, PCB's, motorised volume pot & case for transmiter unit.



Cat K-5591

$39.50

NEW! EA Sept '96

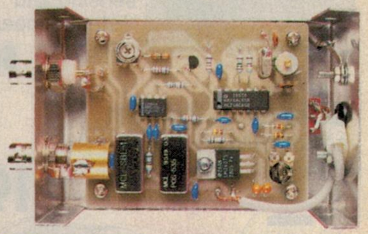
Up Converter For Spectrum Analysers

A compact and easy to build upconverter that allows you to use your spectrum analyser for examining lower frequency signals from about 50kHz up to around 150MHz, by effectively 'translating' them into the UHF band. Supplied in short form with PCB and components only.

Cat K-7621

$79.50 EA Sept '96

NEW!



Sealed Lead Acid Battery Charger

Charge your 12V SLA batteries directly from your car or boat battery. Charges up to 2A to a 13.8V endpoint.

Features:

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Kit supplied complete, including case and front panel label.

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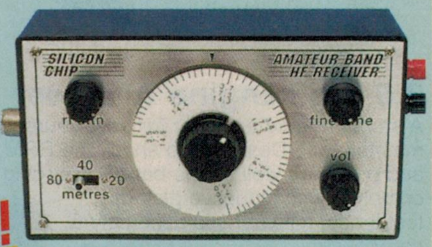
3 Band Amateur Receiver

If you own a cheap short wave radio and are dissapointed with the reception you're receiving from amateur radio signals then this easy to build receiver is for you! You'll be able to listen in to SSB & CW signals on the three most popular HF amateur radio bands (80, 40, 20m). The kit is supplied in full form with all components, hardware, PCB, pre-punched front panel and case.

Cat K-6007

$99

NEW!



SILICON CHIP Sept '96

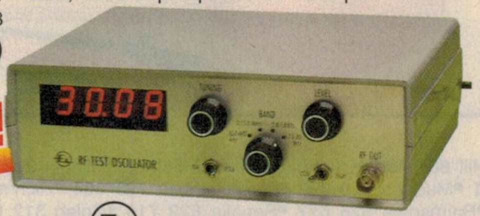
RF Test Oscillator

Test and align your radio and other HF equipment with this new low cost RF Test Oscillator which produces either CW or amplitude modulated signals which may be tuned continuously from 350kHz to over 30MHz. Output is indicated on a four digit LED display. Kit is supplied with all componants, hardware, PCBs, case & pre-punched front panel.

Cat K-7343

$189

NEW!



EA May '96

Now Available 50W Stereo Amp

Features 50W RMS per channel into 8 ohm loads. Ideal for home stereo systems.Protected against thermal runaway, shorts to power-supply rails, undervoltage supply rails, overvoltage from inductive loads and output short circuits. Amplifier provides pre-amp outputs & power amp inputs on rear panel allowing other equipment to be connected in parallel such as additional amplifiers or sub-woofer amp. Kit is supplied in full form with all components, hardware, silk-screened solder-masked PCBs and pre-punched metal work and front panel.

Cat K-5590

$299

EA Jul '96

Availability: Our kits consist of many different parts from numerous suppliers. Whilst we have consulted closely with them and are satisfied as to their ability to supply, sometimes problems can arise in obtaining all of the parts. This means there is a slight chance that availability may be delayed. Rainchecks are available, however if you'd like to check beforehand, please don't hesitate to contact your local store.

Construction Project:

IR REMOTE VOLUME KIT FOR THE 50W/CH AMP

Here's a low cost, easy to build upgrade for the 50W/Channel Stereo Amplifier described in our June and July issues. It consists of two modules — a compact IR transmitter and a matching small receiver assembly — which together give the amplifier the convenience of remote volume control. The receiver module fits neatly inside the amp, while the transmitter fits in a very small handheld case. They're based on the MC145026/MC145027 encoder/decoder ICs from National Semiconductor, and Dick Smith Electronics is selling a kit (K-5591) for only $39.50.

Developed by the R&D section of Dick Smith Electronics, this simplified IR transmitter/receiver combination has been specifically designed to provide a remote volume control option for the 50W Stereo Amplifier. It's closely based on the transmitter and receiver of the Four Channel Infrared Remote Control developed by DSE as part of their Discovery Series (K-2810), and described in our December 1995 issue. In fact the transmitter unit of the K-2810 system is directly compatible with the present receiver.

Because the new transmitter has been designed to fit in a very compact case, it uses a tiny A3-size 12 volt battery. As a result its range of operation is not be as great as the K-2810 transmitter, which uses a 216-type 9 volt battery. This is a direct function of the capacity of each of the batteries. However the new transmitter will operate the receiver reliably over distances of up to three or four metres — which should be fine for most people.

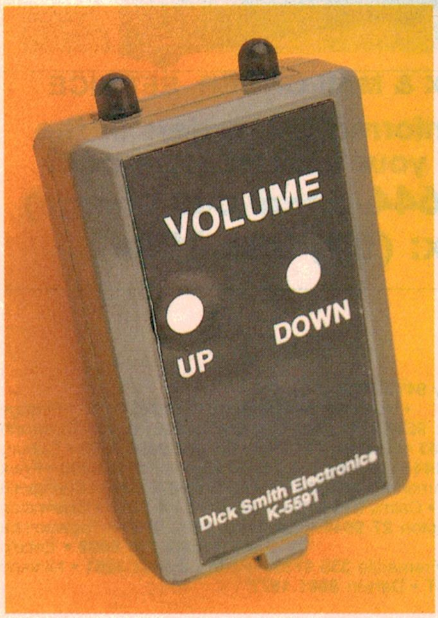
As with the Four-Channel system the chips used in this system allow you to set security codes for both transmitter and receiver. More about this soon, but we suggest that you construct the modules and check them initially without including any security codes. Once the transmitter and receiver have been proven to work, then you can set up security coding if you wish. Needless to say, both must be set up for the same security code.

Transmitter operation

Looking first at the transmitter circuit, there are only two ICs — IC1, the MC145026 security encoder, and IC2 which is a TLC555 CMOS timer used to generate the supersonic carrier. Both chips are only powered when one of the operating pushbuttons SW1 or SW2 is depressed, via diodes D1 or D2. Without a power supply to IC2, the LED driver transistor Q1 is not forward biased and therefore switched off as well.

When SW1 for example is pressed, the supply is enabled to the two ICs via D1, and a high logic level is also presented to the encoder data input D6 pin 6. The D7 input of the decoder, pin 7, is effectively pulled to ground by R4. The encoder senses the states of inputs D6 and D7, and also D8 and D9 which are tied to ground (logic zero) at pins 9 and 10. It therefore transmits this data along with the security code on inputs A1-A5 (pins 1 to 5, when connected).

Note that the code inputs on pins 1 to 5 are *trinary* inputs, and not the traditional binary that is commonly used for logic circuits. Trinary inputs can be set to any of three states, for security encoding: high (1), low (0) or floating (neither high nor low — X). A zero is set by inserting a link between the address input pin and the 0 column, which connects to ground. A



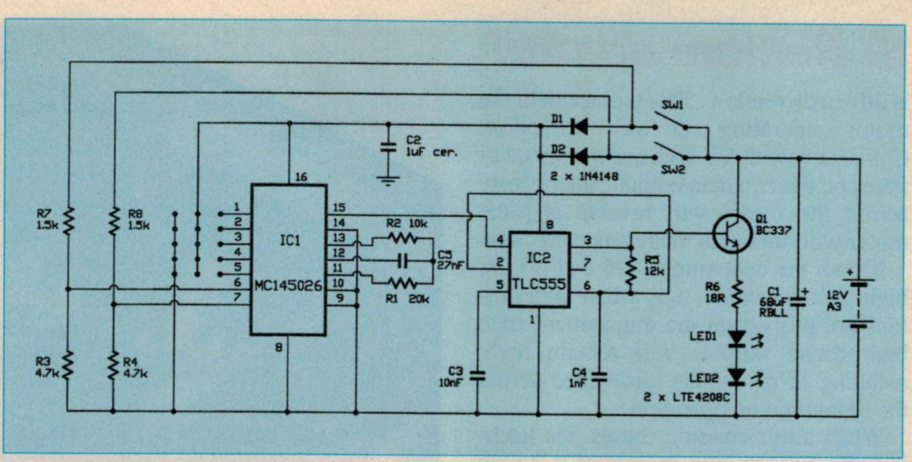
Above: The receiver module mounts above the motorised volume pot, which is fitted to the 50W Amplifier's tone control PCB in place of the original manual pot. Left: The transmitter fits into a very small plastic case. The two pushbuttons are operated through the flexible dress front panel.

floating input is set by having no connection to the address input, and a 1 is set by inserting a link between the address input and the column marked 1, which is the positive supply rail to the IC.

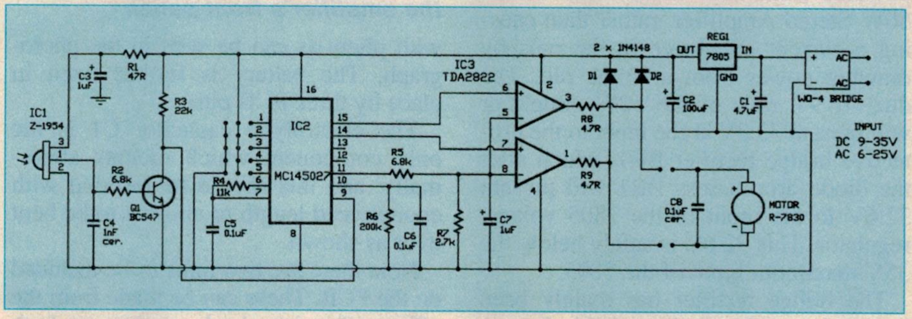
As far as the Data inputs are concerned, and as with the receiver, only D6 and D7 are used (IC1 pins 6 and 7). These Data inputs can also function as trinary address inputs, like A1-A5, but here they are used as two-state on-off data inputs. To ensure that they operate this way, resistors R3 and R4 normally pull the inputs down to ground. When either of the switches is operated, the particular Data input will be raised to a logic 1 while the other input is left at logic 0. This state will be transmitted, along with the address setup on the address pins.

The encoded data/security code sequence emerges from pin 15 of IC1 and is used to gate IC2 on and off. IC2 operates as an astable oscillator at 33kHz, and the 33kHz squareware output from pin 3 is used to control the current through transistor Q1, which drives the two IR transmitting LEDs LED1 and LED2. Resistor R6 controls the LED current.

As a result, when either of the pushbuttons is pressed, the infra-red LEDs are switched on and off at a 33kHz rate, modulated in turn by the encoded digital data/security code sequence. The only difference between pressing one button or the other is that the Data code bits will be different.



Top: The circuit for the transmitter. The two pushbuttons apply power to the circuit, but with different data fed to trinary encoder IC1. IC2 provides the 33kHz modulation, driving Q1 and the IR LEDs.
Below: The circuit for the receiver module. The output from IR detector IC1 is fed to trinary decoder IC2 via buffer Q1, and the decoded outputs from IC2 used to drive the pot motor in one direction or the other via IC3, a stereo amplifier chip used here as a pair of power comparators.



Receiver operation

The receiver module consists of an IR receiver/decoder to receive and demodulate the infra-red signals from the transmitter, plus a motor drive circuit to operate the motor of a standard motor driven dual 50k log potentiometer (DSE Cat No. R-7830).

Looking now at the receiver module schematic, the receiver front-end uses a standard IR receiver IC (DSE Cat. No. Z-1954), IC1, in conjunction with the MC145027 security decoder IC2. The signal from IC1 needs to be inverted before being applied to IC2, and this inverting is done by transistor Q1. Capacitor C3 ensures that the supply fed to the IR device is clean and noise free, while C4 filters high frequency noise from appearing on its output — which could cause false triggering of IC2.

IC2 is the complementary device to the transmitter's MC145026 encoder, and makes four bits of the transmitter's encoded 9-bit trinary security code available as data on output pins 12-15. These are data outputs, referred to as D6-D9. As with the encoder the MC145027 has security code inputs, referred to again as address inputs A1-A5, and these correspond to the same pins on the MC145026.

Only two of the four data bit outputs are used here, D6 on pin 15 and D7 on pin 14. These two data outputs are buffered by IC3, a TDA2822 dual 1W stereo power amp, and used to drive the pot motor.

IC3 makes a very convenient motor driver, because inside its 8-pin package are two class-B outputs of sufficient power to drive the 150mA required by the motor. The dual class-B outputs are needed to drive one terminal of the motor high, while the other is driven low, in a complementary or bridge fashion. IC3 therefore replaces some four transistors which would be needed if this were done with discrete components.

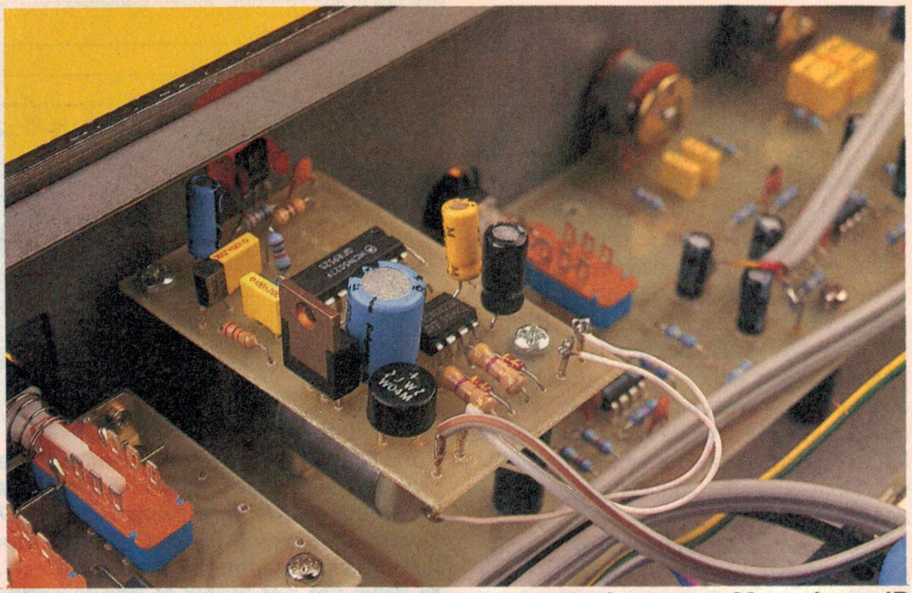
The two 4.7Ω resistors in series with the driver outputs (R8 and R9) are included to limit current to the motor, and also to isolate the motor from the driver as far as spikes from the motor are concerned. Inductive spikes generated by the motor are shunted by capacitor C8, and this should be mounted directly across the motor terminals. If any positive-going spikes should exceed the positive rail, they will be clamped to the rail by diodes D1 D2. Negative-going spikes are clamped by the internal action of IC3.

The operation of decoder IC2 is such that when a valid code is received at its input (pin 9), the data bits of the code are latched onto the IC2 data outputs pins 12-15. When the received security code matches the 5-bit code set on input pins 1-5, pin 11 of IC2 will also go high. This is the Valid Transmission (VT) output, which is here used to enable the motor driver IC.

This enabling of the TDA2822 is done by providing or removing a DC reference level on the negative inputs of the two amplifiers. Both of these amplifiers are configured as comparators, and reducing the DC level on both negative inputs to zero causes both the outputs to switch high. In this state there will be no difference in voltage across the motor terminals.

The comparator action is such that when the level at the positive input is above that of the negative input, the output will go high. On the other hand when the level at the positive input is below that of the negative input, the output will go low.

When a valid transmission is being received, the VT output of IC2 (pin 11) goes high. With one of the IC2 data outputs high and the other low, the comparator operation of IC3 will result in one output of IC3 remaining high while the other



The new PCB board is supported by two tapped spacers 30mm long. IR detector IC1 chip is then positioned directly behind the small 'window' in the amplifier's front panel.

is driven driven low. This will result in the motor operating in one direction. Conversely with VT high and a reversal of states on the two data outputs, the polarity across the motor will reverse and the motor will run but in the reverse direction.

If both the data outputs D6 and D7 are high simultaneously (i.e., when both buttons are pushed on the transmitter), then both driver outputs will remain high, resulting in no voltage difference across the motor and no operation.

When a transmission ceases, the latching effect of the data outputs of IC2 may retain a high output on its pin 14 or pin 15. However at this stage the VT output will go low, and disable the drive to the motor.

The complete receiver circuit is powered from a 5V regulator (REG1). The decision was made to have the circuit powered from *both* supply rails of the 50W Stereo Amplifier, rather than causing a current imbalance in the rails by drawing power from a single rail. The dual 16.9V rails of the 50W Amplifier will present 33.8V at the input to the protective bridge rectifier BR1, which after the diode drop across BR1 will present 32.6V to the input of the 7805 voltage regulator. This 32.6V is safely below the 35V maximum input of the 7805.

The bridge rectifier has mainly been included to make the kit suitable for use with any power supply between 9V-35V DC or 6V-25V AC, so that the modules can be used with other amplifiers if desired. The maximum current drawn is around 150mA.

Transmitter construction

The transmitter is wired on a small PCB designed to fit into the plastic mini-transmitter case shown, although with very little room to spare. Battery terminals are provided for the battery, and these clips will need to be bent into shape with pliers as can be seen in the photograph. The battery is further fixed in place by three PCB pins.

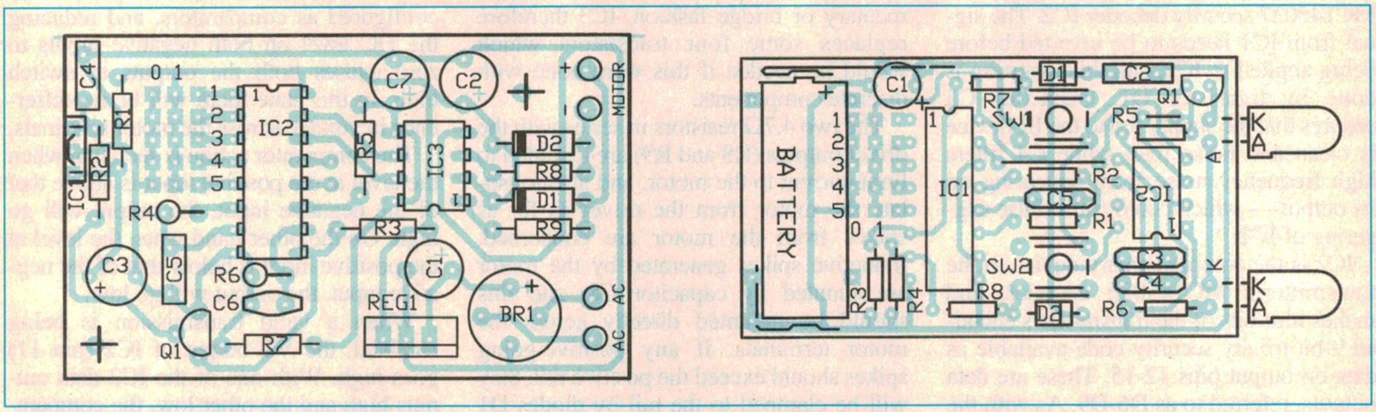
The electrolytic capacitor C1 is the only component which mounts abnormally, and this should be inserted with enough lead length to allow it to be bent over as shown.

Note there are two links to be included on the PCB. These can be made from the offcuts of resistor leads, as they are both quite short in length. The two IR LEDs, LED1 and LED2, will need to have their leads bent at right angles very close to the base of the LEDs themselves. The LEDs should be soldered into place facing forward, and with the rim at the base of each LED touching the surface of the PCB — i.e., as close to the board as possible.

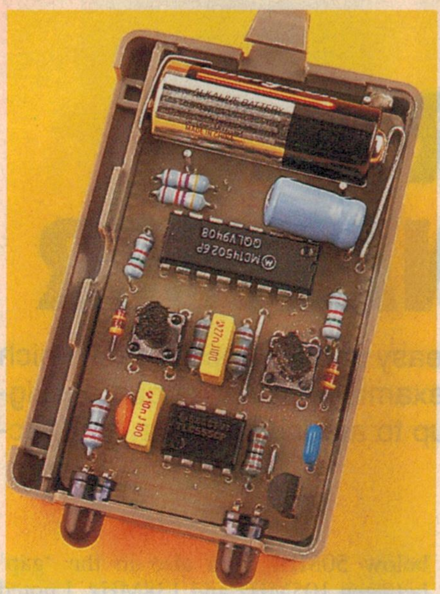
The transmitter is activated by the two micro-switch pushbuttons, and there is no function for the plastic actuator which remains on one side of the case. The pushbuttons are actuated through the flexible plastic sticker on the case top cover.

The mini transmitter case will need four holes made in it — two in the top cover for the microswitches, and two in the front end for the IR LEDs to pass through. To make these four holes, we suggest you drill a small pilot hole first, to establish the correct centre of the desired hole, and then increase the hole size slowly with either larger drill bits or a tapered reamer, until they are the desired diameter.

The holes for the LEDs at the front end of the case have been placed 19mm apart, so that the LEDs don't interfere with the clip action of the case. This clip-shut action happens with the plastic lips of the case directly in between the position of the two LEDs. However to clear the LEDs, some plastic will need to be removed from the top cover of the case. This is best done with a sharp pair of sidecutters. If you remove no more than 6mm from each end of the front flat area, this will leave enough remaining to clear the LEDs when the top



Here's the overlay diagram for the transmitter and receiver modules. With both modules pins 1-5 of the trinary encoder/decoder chips can be linked to either '1' or '0' underneath the PCBs if you wish, in order to provide security coding.



Inside the transmitter case. There's very little room to spare, but everything fits.

cover is fixed into place.

The holes in the flat section of the front face need to be 5mm in diameter, and positioned 3mm in from each end of the face itself. The centre-line of these holes is exactly in line with the height of the walls of the case bottom.

The holes in the top cover of the case are also 5mm in diameter. They are positioned at a distance of 37mm from the back end of the case, or 35mm from the start of the flat indented surface of the top cover. The left switch is closer to the side of the case than the right switch, so position the centre of this hole 3mm from the edge of the indented surface. The right switch is further from the edge and more central, so position the centre of this hole 8mm from the edge of the indented surface.

You may widen the diameter of these holes slightly if you feel it necessary to provide better clearance for the switches, but avoid drilling through the raised surround of the surface, as this will be visible once the sticker is in place.

If the switches are difficult to depress through the sticker on the case top, then a small circular spacer can be stuck on to the sticker. Such a spacer will stick onto the underneath of the sticker and reduce the travel needed to activate the switches.

Receiver construction

Apart from the motorised pot and its filter capacitor C8, virtually all components for the receiver section are contained on a 64 x 38mm single sided PCB. The assembly of the board is quite straightforward, and should give no problems if you use the overlay diagram and photographs as a guide.

The two PCB mounting holes are to suit similarly spaced holes on the preamp board of the 50W Stereo Amplifier. The idea is that the PCB is mounted on the preamp board via two 30mm spacers, so that it sits at the right height to clear the motorised pot, and also for the IR receiver IC to sit squarely behind the front panel IR bezel. If any pins or links stick out from under the PCB and are close to the pot case, then clip these off with sidecutters to ensure no accidental contact with the case.

Remember that the power supply for this circuit is unbalanced and not directly referenced to the amplifier's ground rail. Use the tag of the 7805 regulator for your local ground reference when measuring with a multimeter of oscilloscope — should any troubleshooting be necessary.

Testing and coding

When you have finished wiring up both modules, it would be a good idea to test their basic operation before fitting the receiver module into the amplifier. You can do this by connecting the reciever module temporarily to the amplifier's power rails and the motor on the amplifier's volume pot, via longer lengths of hookup wire than will finally be used. That way, the receive module can be tested sitting outside the case.

With the amplifier turned on, you should be able to activate the pot motor using the buttons on the transmitter unit. There are no adjustments to be made, so if all is well the Up button should make the motor turn the pot clockwise, and the Down button should cause the reverse.

If neither button produces any result, you have a problem in either the transmitter or receiver — so turn off, and investigate. Most likely you will have fitted a component to one PCB or the other the wrong way around, or perhaps produced an accidental solder bridge. If you can't spot any such errors, you may need to re-apply the power and measure a few voltages. The odds are that one of these will be wrong, and provide a clue as to where the problem lies.

If the buttons both produce action, but they work in reverse, the cause will be simple: you have reversed the connections to the pot motor. The solution to this one is easy — simply turn off the amplifier, reverse the motor connections and try again.

Once everything is working properly, you can decide whether you want to wire the security coding links. If you do, the main thing to ensure is that the links you fit to the transmitter are in exactly the same positions as those you fit to the receiver. Otherwise, you can please yourself as to whether each of the five pins is tied low, tied high or left floating.

With the security coding links in place (or left out, as you wish), the transmitter case can be closed, and the receiver module mounted permanently in the amplifier. Don't forget to cut the temporary leads to a much shorter length, to suit the final board position — if you leave them long, they'll probably end up getting jammed under the case lid, or otherwise cause trouble.

You should now be able to sit back and enjoy the convenience of adjusting your amplifier's volume, without getting up from your favourite chair. ❖

PARTS LIST

Transmitter module

Resistors

All 1/4W 1% metal film:

R1	20k
R2	10k
R3,4	4.7k
R5	12k
R6	18 ohms
R7,8	1.5k

Capacitors

C1	68uF 16VW RB electro
C2	1uF monolithic ceramic
C3	10nF MKT
C4	1nF ceramic
C5	27nF MKT

Semiconductors

D1,2	1N4148 or similar
Q1	BC337 or similar NPN
LED1,2	LTE4208C IR LED
IC1	MC145026 trinary encoder IC
IC2	TLC555 timer IC

Miscellaneous

SW1,2	Microswitch buttons

PCB, 55 x 31mm; 12V battery, A3 size; transmitter case, 60 x 39 x 16mm; stick-on front panel label; battery contacts; 3 x PCB terminals pins.

Receiver module

Resistors

All 1/4W 1% metal film:

R1	47 ohms
R2,5	6.8k
R3	22k
R4	11k
R6	200k
R7	2.7k
R8,9	4.7 ohms

Capacitors

C1	4.7uF RB electro
C2	100uF 16VW RB electro
C3,7	1uF16VW RB electro
C4	1nF ceramic
C5,6	0.1uF MKT
C8	0.1uF ceramic

Semiconductors

D1,2	1N4148 or similar
Q1	BC547 or similar NPN
IC1	IR receiver/demodulator (DSE Z-1954)
IC2	MC145027 trinary decoder IC
IC3	TDA2822 stereo amp IC
REG1	7805 5V regulator
BR1	WO-4 or similar bridge

Miscellaneous

PCB, 39 x 65mm; motorised stereo pot assembly, dual 50k log (DSE Cat. No. R-7830); 2 x 30mm long tapped spacers; 4 x PCB terminal pins.

Construction Project:

UPCONVERTER FOR OUR SPECTRUM ANALYSER

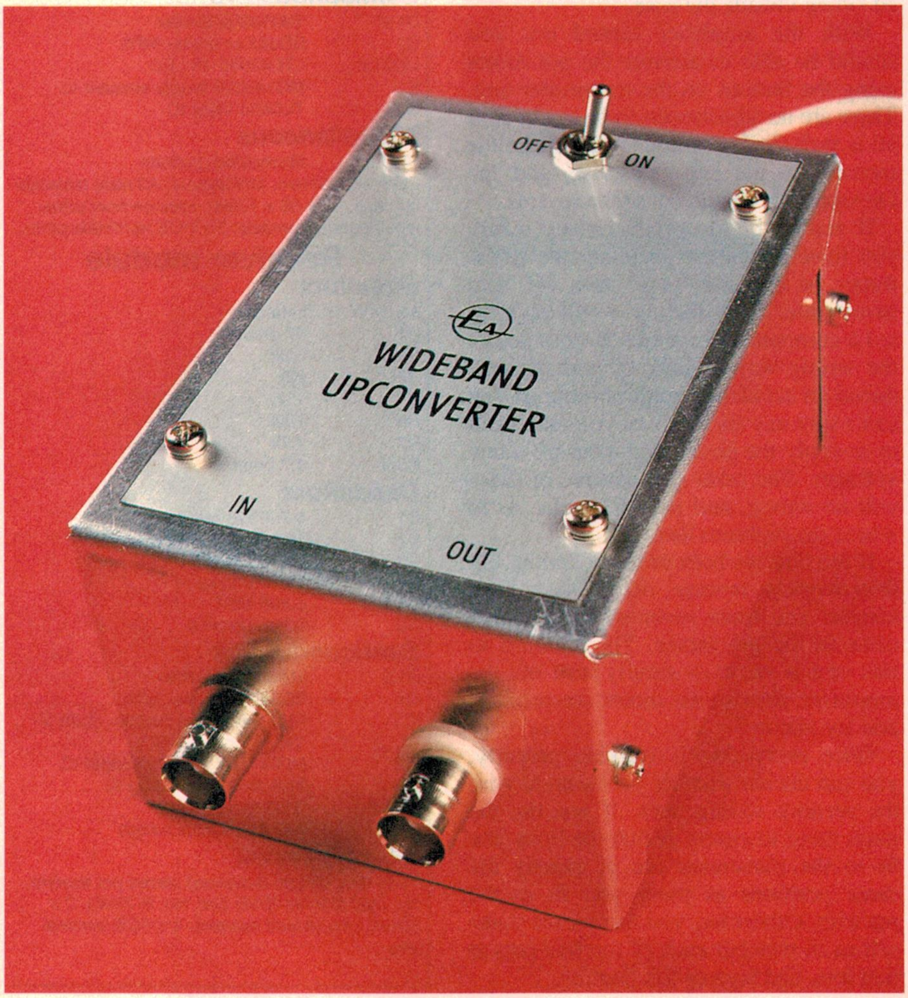
In response to many requests, here it is — at last! A compact and easy to build upconverter which allows you to use our popular VHF/UHF Spectrum Analyser for examining lower frequency signals. In fact it can be used to examine signals from about 50kHz up to around 300MHz, by effectively 'translating' them into the UHF band.

by JIM ROWE

In the September and October 1992 issues of *EA*, I described a low cost Spectrum Analyser design which turned out to be rather popular. At least one of the main kit suppliers is still selling kits for it, and I believe many hundreds have been built.

But because the Analyser used a VHF/UHF TV tuner module for its 'front end', it did have one fairly obvious limitation: it could only be used to examine those parts of the spectrum occupied internationally by the VHF and UHF TV channels (i.e., 50 - 105MHz, 138 - 225MHz and 470 - 870MHz).

This still allowed it to be used to examine quite a lot of different signals, of course. All the same, it would obviously have been even more useful if it had the ability to 'look at' the spectrum



below 50MHz, and also in the 'gap' between 105MHz and 138MHz. I noted this at the time, and foolishly offered to describe a suitable upconverter to add this capability, if there proved to be sufficient reader interest.

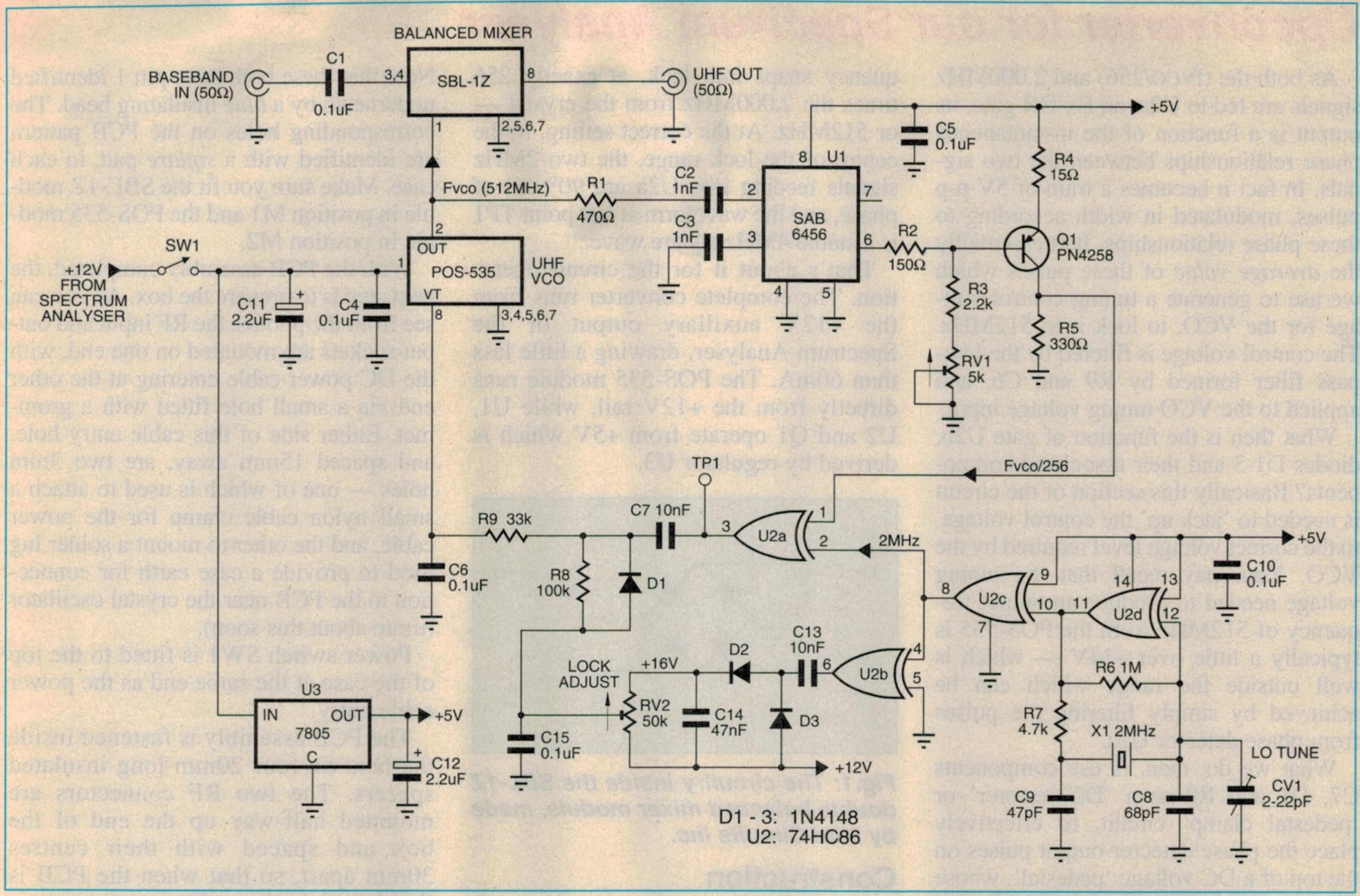
Well, it soon became clear that there was indeed sufficient reader interest. In fact since the Analyser was first described, I've had a steady stream of requests for the upconverter. The only difficulty has been finding the time to come up with a design that I felt was good enough to describe!

Finally, though, this has been achieved. The design to be described here is fairly low in cost, and also quite easy to set up. It is essentially very straightforward: a crystal-locked 512MHz local oscillator signal is fed to a double-balanced mixer, along with the incoming low frequency signals, to 'translate' them up into the UHF band where they can be examined by the Analyser.

There is no gain ahead of the mixer, to minimise the risk of overload and cross modulation. As the mixer has a small conversion loss (around 6 - 8dB), this means that the Analyser and Upconverter combination is not as sensitive as the Analyser alone. However it's still quite respectable, with signals of less than 75 microvolts able to be resolved.

As the upconverter's local oscillator frequency of 512MHz is down near the bottom of the Analyser's UHF band, it provides an effective LF/HF band which extends from about 50kHz up to beyond 300MHz — in a single band. So it not only covers the 'missing bottom end', but also the Analyser's original VHF bands and the gap between them...

As before, the Analyser's sweep width control can be used to set how much, and which part of this new band you examine. For example you can display virtually the complete span, or nar-



Basically the Upconverter uses an SBL-1Z balanced mixer to heterodyne the incoming low frequency signals against a UHF local oscillator. Most of the circuitry forms a PLL, used to lock the local oscillator frequency at 512MHz.

rower segments down to a range as narrow as about 5MHz.

All of the converter's circuitry fits on a PC board measuring only 64 x 77mm, which fits inside a small metal utility box. It's also powered from 12V DC supplied directly from the Spectrum Analyser itself, making it very easy to use as an 'accessory'.

How it works

At the heart of the upconverter are two small RF modules, and it's these which make the unit a lot easier to build and get going than it would otherwise be. Both modules are made by US firm Mini-Circuits Inc., and are available in Australia from that firm's distributor Clarke & Severn Electronics.

One module is the wideband balanced mixer, an SBL-1Z. This is basically a ring of high speed diodes, together with a pair of wideband RF transformers (Fig.1). The SBL-1Z is similar to the lower cost SBL-1, but is rated to have a higher bandwidth.

(The SBL-1 can in fact be used, but it will give a higher conversion loss — especially at higher frequencies.)

The upconverter's low frequency 'baseband' input signals are fed directly to the 'IF' port of the SBL-1Z, via blocking capacitor C1 (see schematic), while the 512MHz local oscillator signal is fed to the 'LO'(L) port. The resulting sum-and-difference UHF output signals appear at the 'RF'(R) port, and it's these signals which are fed to the Spectrum Analyser.

The rest of the upconverter's circuitry is essentially used to provide the 512MHz local oscillator signal. The signal itself is generated by the second Mini-Circuits module, which as you can see is a POS-535. This is a UHF voltage-controlled oscillator or VCO, in a compact 8-pin package like that used for the mixer.

The POS-535 can be tuned from below 300MHz to above 525MHz, by means of a positive DC voltage applied to pin 8. The tuning voltage to produce an output frequency of 512MHz is typically a little over 14V. Here we use a phase-locked loop (PLL) system to control the tuning voltage and maintain the VCO module's frequency at exactly 512MHz.

The main elements in the PLL are U1, an SAB6456 UHF frequency divider, transistor Q1 and U2, a 74HC86 quad Ex-OR gate. U1 is used to sense the output signal from the VCO, via series resistor R1 and blocking capacitor C2. As U1 is set up to divide by 256, its output (from pin 6) is therefore (fVCO/256) or 2MHz, when the POS-535 is operating at the correct 512MHz.

Q1 is a PN4258 high-speed PNP transistor, used here as a level converting buffer. It's needed because U1 is an ECL (emitter-coupled logic) device, with an output voltage swing that is not directly compatible with TTL or HCMOS devices. When the bias on Q1 is correctly set up via preset pot RV1, its action is to convert the ECL signal from U1 into a rectangular waveform signal of nearly 5V p-p, across collector load resistor R5.

This signal is the (fVCO/256) signal in HCMOS compatible form, and is fed to pin 1 of U2a, which serves as the PLL's phase detector. Here it is compared with a 2MHz signal derived from quartz crystal X1.

X1 is connected in a standard crystal oscillator circuit, using U2d connected as an inverter with R6 providing DC feedback to bias it in the linear region. Trimmer capacitor CV1 allows the oscillator to be adjusted to an accurate 2.000MHz. Gate U2c is then used as an inverting buffer, to prevent any possible 'pulling' of the oscillator due to loading variations. The output of U2c is therefore a stable and accurate 2.000MHz, which is fed to pin 2, the second input of U2a.

As both the (fVCO/256) and 2.000MHz signals are fed to U2a, an Ex-OR gate, its output is a function of the instantaneous phase relationships between the two signals. In fact it becomes a train of 5V p-p pulses, modulated in width according to these phase relationships. It is essentially the *average value* of these pulses which we use to generate a tuning control voltage for the VCO, to lock it to 512MHz. The control voltage is filtered by the low-pass filter formed by R9 and C6, and applied to the VCO tuning voltage input.

What then is the function of gate U2b, diodes D1-3 and their associated components? Basically this section of the circuit is needed to 'jack up' the control voltage, to the correct voltage level required by the VCO. You may recall that the tuning voltage needed to produce an output frequency of 512MHz from the POS-535 is typically a little over +14V — which is well outside the range which can be achieved by simply filtering the pulses from phase detector U2a.

What we do, then, is use components C7, D1 and R8 as a 'DC restorer' or 'pedestal clamp' circuit, to effectively place the phase detector output pulses on the top of a DC voltage 'pedestal', whose height is adjusted by preset pot RV2.

You might think that it would be sufficient to simply return the bottom end of D1 and R8 to the +12V supply rail, and rely upon the average value of the phase detector output pulses to raise the VCO tuning voltage to the correct level, to achieve phase locking. That's what I thought originally, too! However this arrangement proved to be incapable of producing quite enough voltage to achieve initial locking, with some POS-535 devices. (In particular, those which needed a relatively high tuning voltage to achieve an output of 512MHz.)

To make sure that all VCO devices can be brought into lock, I had to come up with the arrangement shown. Here gate U2b is used as a buffer, making use of our crystal-derived 2MHz signal to drive a rectifier circuit using capacitors C13 and C14, and diodes D2 and D3.

As you can see, the rectifier circuit is referenced to the +12V rail rather than ground. As a result, it develops across trimpot RV2 a DC voltage which varies from +12V at the bottom to approximately +16V at the top. RV2 therefore allows the control voltage 'DC pedestal' to be adjusted over this range, with C15 used to provide additional filtering of any 2MHz component.

RV2 becomes the PLL's lock adjustment, and is adjusted until the VCO frequency snaps into lock, at exactly 256 times the 2.000MHz from the crystal — or 512MHz. At the correct setting, in the centre of the lock range, the two 2MHz signals feeding into U2a are 90° out of phase, and the waveform at test point TP1 is a stable 4MHz square wave.

That's about it for the circuit operation. The complete converter runs from the +12V auxiliary output of the Spectrum Analyser, drawing a little less than 60mA. The POS-535 module runs directly from the +12V rail, while U1, U2 and Q1 operate from +5V which is derived by regulator U3.

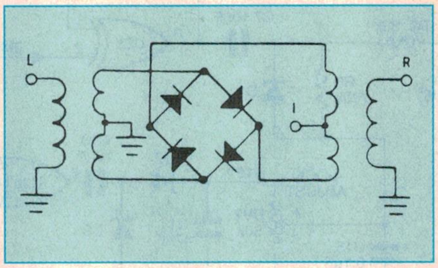


Fig.1: The circuitry inside the SBL-1Z double balanced mixer module, made by Mini-Circuits Inc.

Construction

The overall construction of the converter can be seen from the photographs. As mentioned earlier, virtually all of the circuitry is mounted on a small PCB, measuring 76 x 64mm and coded 96ucv9. This is mounted in turn inside a small metal utility box, measuring 102 x 70 x 50mm and readily available. The only parts not mounted on the PCB are the DC power switch SW1 and the input and output BNC connectors.

Assembling the components on the PC board should be fairly straightforward if you use the internal photo and PCB overlay diagram as a guide. As usual check the board carefully for any etching faults, and if necessary correct these before fitting any of the parts.

I suggest that you fit the seven PCB terminal pins first (two each for RF in and out and power, one for TP1), then the resistors, trimmer cap, trimpots and fixed capacitors in that order — taking care with the polarity of tantalum caps C11 and C12. Then you can fit the voltage regulator U3 (using an M3 x 10mm machine screw and nut to hold down its heatsink tab), transistor Q1, diodes D1-3 and ICs U1 and U2. Watch the orientation of all of these latter devices, to prevent errors; the overlay diagram can be used as a guide.

The last step is to fit crystal X1, and the two Mini-Circuits modules M1 and M2. Note that these both have pin 1 identified underneath by a *blue* insulating bead. The corresponding holes on the PCB pattern are identified with a *square* pad, in each case. Make sure you fit the SBL-1Z module in position M1 and the POS-535 module in position M2.

With the PCB assembly completed, the next step is to prepare the box. As you can see from the photos, the RF input and output sockets are mounted on one end, with the DC power cable entering at the other end via a small hole fitted with a grommet. Either side of this cable entry hole, and spaced 15mm away, are two 3mm holes — one of which is used to attach a small nylon cable clamp for the power cable, and the other to mount a solder lug used to provide a case earth for connection to the PCB near the crystal oscillator (more about this soon).

Power switch SW1 is fitted to the top of the case at the same end as the power cable entry.

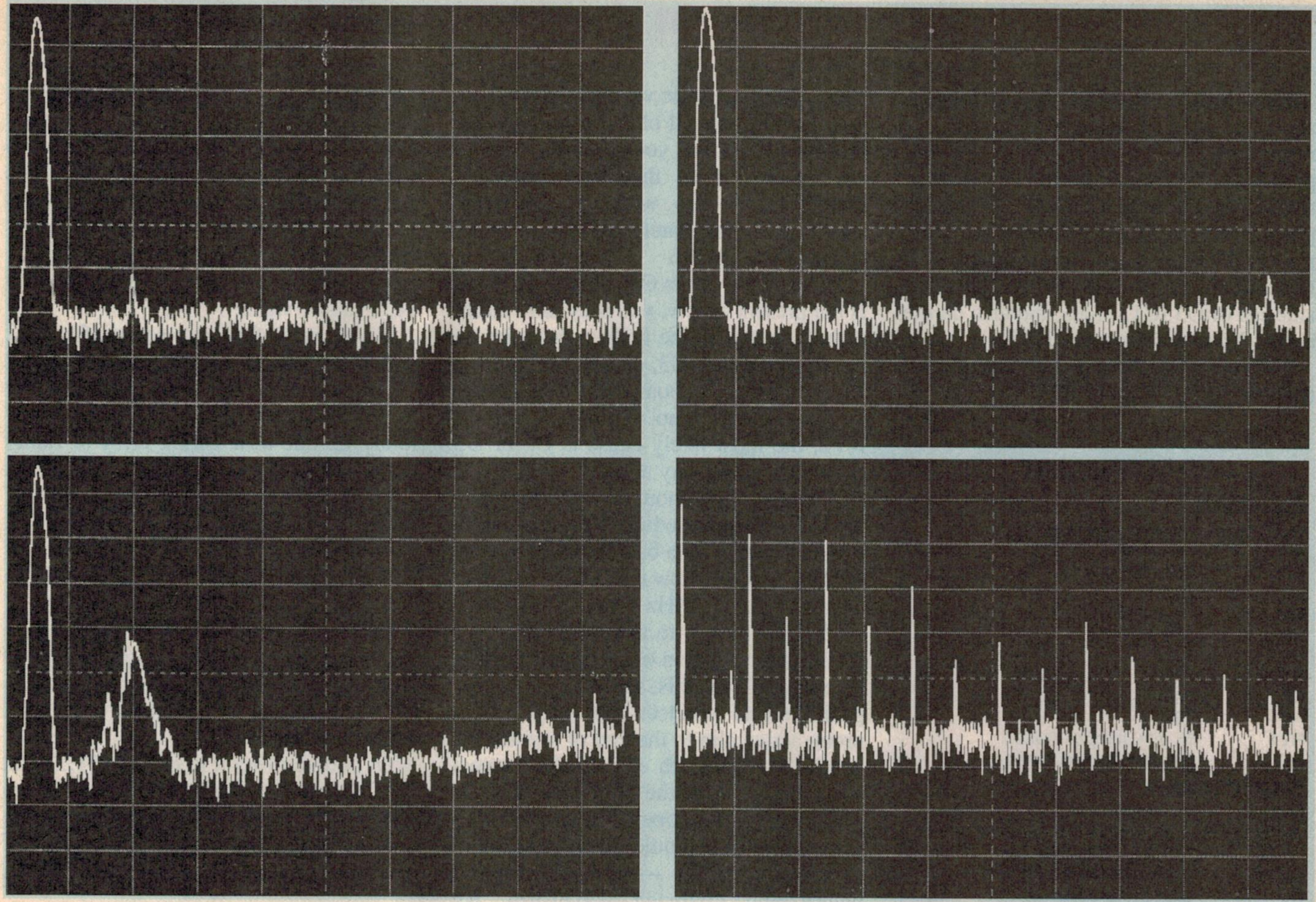
The PCB assembly is fastened inside the box via four 20mm-long insulated spacers. The two RF connectors are mounted half-way up the end of the box and spaced with their centres 30mm apart, so that when the PCB is fitted into the box, the socket connection tabs are very close to their respective PCB terminal pins.

Both RF connectors are of the single-hole mounting BNC type, but note that the RF input connector is of the non-insulated type, while the output connector has an insulating ferrule. This is to minimise earth loops and circulating currents.

To prepare the box, then, you'll need to cut the two holes in one end for the two BNC sockets, the hole in the centre of the other end for the power cable grommet, and the two adjacent 3mm holes. You'll also need to drill four holes in the top of the case for the PCB mounting pillar screws, and the hole for power switch SW1.

A photocopy of the front panel artwork (reproduced actual size in the article) can be used as a template for the position of the holes in the front panel. When these holes are drilled, the dress front panel itself can be fitted, followed by the switch and finally the four screws used to attach the PCB mounting pillars.

At this stage you should be able to fit the two BNC connectors and the power cable entry grommet, together with the nylon cable clamp and the solder lug. (The latter two are attached via M3 x 10mm machine screws with lockwashers and nuts.) Then you can also fit the PCB assembly inside the box, on the free ends



Captured using our DSO Adaptor Mk2, the above displays show what can be achieved using the Upconverter. At top are sweeps using the lowest sweep width, with the 512 MHz 'DC' reference at far left, and 75uV signals at 1MHz (top left) and 5MHz (top right) respectively. Lower left shows the signals from an antenna displayed on the same scale, with the AM broadcast stations jumbled around 1MHz. And lower right is with sweep width of 150MHz, displaying the output from the small 10MHz Comb Generator to be described next month. The small additional 'spike' apparent at about 15MHz is breakthrough from the SBS-28 picture carrier — quite strong in the author's area.

of the insulating pillars.

The 12V DC power connections can now be made. The cable uses a 2m length of light-duty shielded lead, with the inner conductor used for the positive lead and the outer braid for negative. The main lead enters via the grommet, passes through the cable clamp and is then terminated on the two *outer* switch lugs — with the braid connecting to the lug on the side nearer to trimcap CV1 on the PCB.

A 90mm length cut from the end of the lead is then used to make the connections between the switch and the supply pins on the PCB, with the braid connecting to the same switch lug as the main cable braid, and the inner conductor to the centre switch lug.

The RF connections between the PCB and the BNC sockets are best made using short strips of shim copper or brass, about 3mm wide to ensure that they have relatively low inductance. Actually in the case of the RF input socket, it's a good idea to make the 'earth side' connection out of a somewhat larger piece of shim, which can be curved around to make a semicircular shield around the active input connection (see photo). This will minimise any tendency for the input to pick up radiation from the converter's 2MHz crystal oscillator, or the 4MHz signal at the output of the PLL phase detector.

The final assembly step for the converter itself, at this stage, is to use a short length of copper braid, or multi-strand hookup cable, to make an additional earth connection to the PCB. This runs from the solder lug on the cable entry end of the box, to the earth track on the side of the PCB, just adjacent to crystal X1 and resistor R7. Make the lead as short as possible, to provide a low impedance path. The purpose of this additional earth connection is again to minimise the level of 2MHz and 4MHz signals finding their way into the mixer circuitry.

All that remains, before you can check out the converter, is to fit a concentric DC power plug to the Analyser end of the power lead. Make sure you wire it so that when you plug it into the matching socket on the rear of the Analyser, wired to the Analyser's +12V and earth rails, the lead's inner conductor connects to +12V.

Testing & adjustment

You should now be ready to fire up the Analyser and Upconverter, and run though the converter's checkout and setting-up procedure.

For the initial checkout, all you'll need is a DMM set to say the 20V DC range. To begin, power up the Analyser and switch the converter's power switch to the OFF position. Then plug the converter's power lead into the Analyser's 12V outlet socket, and use the DMM to check that 12V appears across the outer lugs of the switch — with the lug connected to the 'inner' side of the cable more positive. If the polarity is reversed, unplug from the Analyser and work out where you've made the mistake; then fix it before proceeding any further.

Upconverter for our Spectrum Analyser

If the polarity checks OK, clip the negative test lead of the DMM to the box metalwork. Then switch SW1 to the ON position, and quickly use the DMM positive lead to check that there's +12V at the power inlet pin near C11, and also on the pin of U3 nearest the same capacitor. If this is OK, check for +5V on the other side pin of U3 (C13 side), and also on the end of R4 nearest trimpot RV1.

The remaining voltage to measure is at the end lug of trimpot RV2 nearest U3. This should measure very close to +16V.

Assuming that all of these voltages are present and correct, your converter should be functioning in the basic sense. If there's a problem with any of them, switch off immediately and look for the cause of the trouble.

If the +12V rail is OK but the +5V rail is not present or low, you may have either a short circuit on the PCB, a dry joint on the output pin of U3, or one of the other ICs fitted to the board the wrong way around. If there's no +16V at the top of RV2, the most likely cause is D2 or D3 fitted the wrong way around.

All being well, though, you'll be ready for the setup procedure. For this you'll need a scope, with a bandwidth of at least 20MHz or so to allow reasonably accurate examination of 2MHz and 4MHz signals.

The first step is to adjust trimpot RV1 for correct operation of the buffer transistor stage. To do this, set RV1 to its mid position and connect the scope's test probe active clip to the end of resistor R5 nearest U2. Its earth clip should connect to the other end of the same resistor.

Adjusting the scope timebase and triggering controls should show some kind of signal at 2MHz — probably a rather peaky and distorted waveform. By adjusting RV1, though, you should be able to change the waveform into a clean and fairly rectangular 2MHz squarewave, of nearly 5V p-p. This is the correct setting for RV1, but don't turn the trimpot any further clockwise than is necessary to achieve a clean and rectangular waveform.

Now you should be ready to set the PLL for correct locking. To do this, set trimpot RV2 to its fully **anticlockwise** position, and move the scope probe's active clip to the TP1 test pin between U2 and U3. (The earth clip can be left attached to the outer end of R5.)

Initially, you'll almost certainly see a train of pulses which are rapidly varying in width, and probably impossible to view stably on the scope screen. But then, watching the scope pattern, slowly turn RV2 clockwise. Before long, the pulses should suddenly stop varying in width, and become stable. If your scope is calibrated, you should discover that they have a frequency of 4MHz.

Further careful adjustment of RV2 should show that the pulses will remain stable over a small adjustment range, with only the mark/space ratio of the pulses varying within that range. The correct setting for RV2 is in the middle of the range, with the 4MHz waveform having as close as possible to a 1:1 mark-space ratio — i.e, a square wave.

If you can't find *any* setting for RV2 which results in a stable waveform at TP1, your PLL is for some reason not able to pull into lock. This would almost certainly be due to a wiring error or faulty component, so switch off and investigate. Look for resistors in the wrong positions, diode D1 perhaps around the wrong way, or something similar.

Assuming you have been able to achieve a stable 4MHz squarewave at TP1, though, your converter should now be operating correctly, with the VCO locked to a frequency very close to 512MHz — i.e., at 256 times the crystal oscillator frequency.

Of course to set it to exactly 512MHz, you'll need to set the crystal oscillator to 2.000MHz using a frequency counter, and by adjusting trimmer cap CV1. If you have access to a counter, by all

PARTS LIST

Resistors

All 0.25W 5% unless specified)

R1	470 ohms
R2	150 ohms
R3	2.2k
R4	15 ohms
R5	330 ohms
R6	1M
R7	4.7k
R8	100k
R9	33k
RV1	5k min. trimpot (horiz.)
RV2	50k min. trimpot (horiz.)

Capacitors

C1,4,5, 6,10,15	0.1uF monolithic ceramic
C2,3	1nF monolithic ceramic
C7,13	10nF monolithic ceramic
C8	68pF NPO ceramic
C9	47pF NPO ceramic
C11,12	2.2uF tantalum electro
C14	47nF monolithic ceramic
CV1	2-22pF plastic dielectric trimcap

Semiconductors

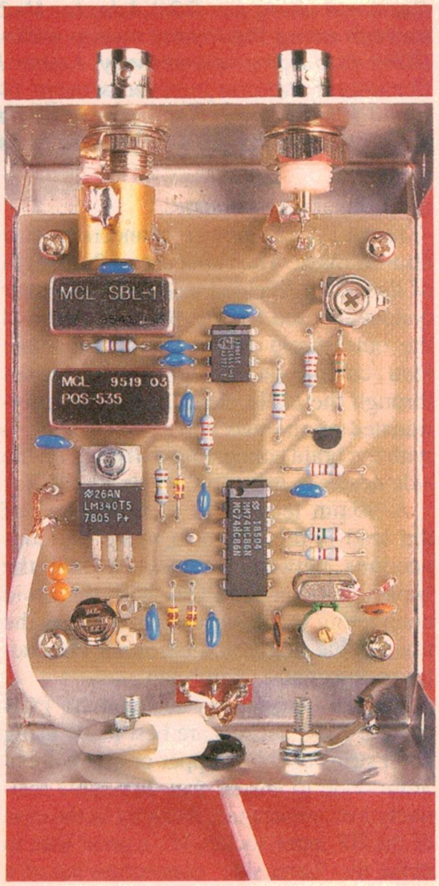
D1,2,3	1N4148 or similar diode
Q1	PN4258 high speed PNP
U1	SAB6456 UHF divider IC (DIP version)
U2	74HC86 quad Ex-OR gate
U3	7805 regulator (TO-220)

Miscellaneous

M1	SBL-1Z double balanced mixer*
M2	POS-535 UHF VCO module*
X1	2.000MHz quartz crystal
SW1	Miniature toggle switch, SPDT
J1	BNC socket, panel mounting uninsulated
J2	BNC socket, panel mounting insulated
PCB	76 x 64mm, code 96ucv9

Metal utility box, 102 x 70 x 50mm; front dress panel, 90 x 60mm; 4 x 20mm insulated spacers, with screws and lockwashers; 2m length of shielded cable, for 12V power lead; miniature coaxial power connector; rubber grommet, 6mm hole size; nylon cable clamp, 5mm size; solder lug; three M3 x 10mm machine screws with nuts and star lockwashers; 7 x PCB terminal pins; small piece of shim copper or brass for making input shield, output socket connections; hookup wire, solder etc.

***The SBL-1Z mixer and POS-535 VCO modules are manufactured by Mini-Circuits Inc, of New York. They are available in Australia from Clarke & Severn Electronics, of Unit 4, 8A Kookaburra Road, Hornsby Heights NSW (PO Box 1, Hornsby, 2077); phone (02) 9482 1944 or fax (02) 9482 1309.**



A view inside the converter prototype, showing where everything goes. Note the small shield over the connection to the RF input socket, at upper left. The wire visible at lower right earthing the crystal can is not necessary.

means use it to make this adjustment — measure the 2MHz signal at pin 8 of U2, and simply adjust CV1 to get an accurate 2.000MHz. In some cases, you may need to change the value of C8 to allow this frequency to be achieved.

If you don't have access to a counter, it should be quite satisfactory for most purposes to simply set CV1 to its mid position. The resulting error at 512MHz will probably be no more than 100kHz.

With this final adjustment completed, your upconverter should be ready for use. All that remains is to fit the other half of the box, and connect its RF output to the Spectrum Analyser's input.

Using it

After connecting the upconverter's output to the input of the Spectrum Analyser, switch the Analyser to the UHF range and set the Sweep Width switch to the maximum position. Also set the Centre Frequency Coarse switch to the third position, the Fine pot to mid rotation and the RF Gain pot to minimum (fully anticlockwise). The Bandwidth switch can be set to High, and the Sweep Rate pot to its midway position.

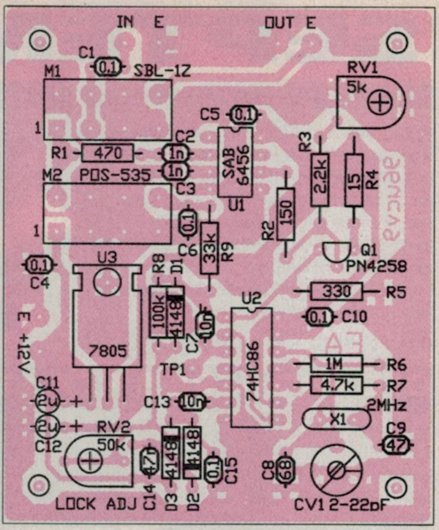
Now turn on the Upconverter, and slowly turn up the Analyser's RF Gain. A fairly prominent signal 'spike' should appear, to the left of the screen centre. This is breakthrough from the Upconverter's 512MHz local oscillator, and when the Upconverter is being used you'll find this spike or peak a convenient reference because it effectively marks the 'DC' or zero frequency point for the upconverted LF band. In other words, it marks the 'start' of your new LF band.

When the Upconverter is in use, the best setting for the Analyser's RF Gain control is where this 512MHz peak can be giving the largest height on the Analyser display, before the baseline 'grass' level begins to dip downwards on either side. (This dipping indicates overload of the Analyser front end.)

You'll soon notice that as well as displaying upconverted LF signals to the right of the 512MHz peak, the Analyser will also show 'mirror image' signals to the left of the peak. These are the converter's 'difference' products, as opposed to the 'sum' products. While these difference signals can be used if you wish, they can only be displayed down to 470MHz or so and are effectively on a 'reversed frequency' scale (i.e., increasing frequencies moving left). In most cases it's more convenient to adjust the Analyser's Centre Frequency controls so that the 512MHz peak is close to the left-hand end of the display, and concentrate only on the 'sum' products to its right.

Apart from this, operation of the Analyser/Upconverter combination is more or less the same as using the Analyser by itself. The Sweep Width control is used to adjust how much of the upconverted spectrum is swept and displayed, while the Centre Frequency controls are used to select which part of the range you concentrate on.

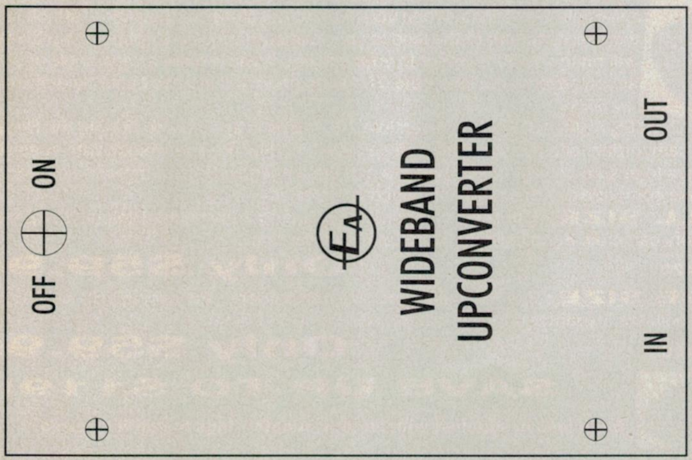
As mentioned, the 512MHz peak provides a convenient marker for the 'start' of the converted LF band, and it's often convenient to have it just visible at the left-hand end of the screen. This has been done in the sample displays shown, as you can see. However there's no reason why you can't 'zoom in' to some other part of the upconverted range, if you wish.

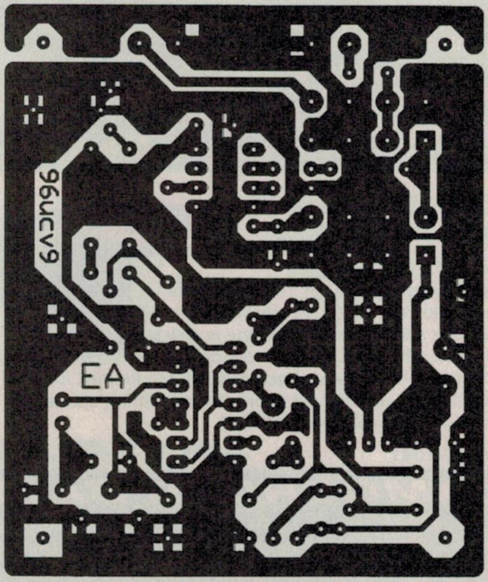


Use this overlay diagram as a guide when you're wiring up the converter PCB. Pin 1 of each Mini-Circuits module is identified underneath with a blue insulating bead; these pins mate with the square PCB pad in each case.

To assist you in navigating the spectrum away from the 512MHz reference peak, I've developed a simple little 'frequency comb' generator which produces a set of reference spikes on 10MHz and its multiples, up to around 150MHz. I'm planning to describe this in the next month or so, and you might want to build it as a handy accessory.

In the meantime, I hope you'll find the Upconverter as useful as I've done, since developing it. In closing, I'd like to thank Gordon Clarke of Clarke and Severn, for his help in obtaining Mini-Circuits devices and data. ❖





Above: Here's the front panel artwork, actual size as usual. A photocopy can be used as a template, to mark the position of the holes in the box front panel.
Right: The PCB pattern for the Upconverter, reproduced here actual size again for those who prefer to etch their own boards.

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

SEPTEMBER AT JAYCAR

SPEAKER DAMPENING MATERIAL

NEW

Brand new product. The better way to deaden your speaker boxes. White on one side, grey on the other. Ideal if your car subwoofers are on display - you can line them with grey material, instead of the usual white. Supplied in a single pack of one piece which measures 1mtr. x 700mm. 330gsm. New low price also.

NEW

Cat. AX-3690 **Only $6.95**

CABLE TIE TIDY KIT

Keep your cabling neat and tidy. Ideal for Hi Fi's, videos, surround sound, cars etc. Consists of:- 30 x 120mm cable ties 20 x 120mm reusable cable ties 10 x self adhesive cable tie mounts 20 x saddle type cable tie mounts

Cat. HP-1198 **Only $4.95**

60 CD HOLDER

NEW

Alpha brand "made in USA" CD holder. Colour is black and it has two opening doors, with magnetic catches to keep doors closed. Will hold 2 double CD's and has rubber feet to protect furniture and prevent shifting. Made from black plastic. Size 413(H) x 320(W) x 160(D)mm.

Limited quantity available. Cat. AR-1482

Retail Price $59.95

Save $30.00 Our Price $29.95

OFC PRO SERIES RCA LEADS

Top quality OFC Pro Series RCA audio leads with gold plugs and central lead wire for remote switching of car amps, or for grounding on Hi Fi home systems. Cable is figure 8 OFC blue colour with an OD of 6mm each side. Plugs are gold plated and mounted to the cable. Each lead has two RCA plugs on each end.

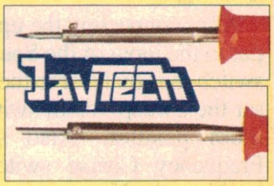
NEW

Specifications.

- Material: Oxygen free copper
- Centre conductor: 19 x 0.18
- Switch wire: 19 x 0.18
- Shielding : 112 x 0.12
- Shield type: Spiral
- Outside diameter: 6 x 12mm
- Foam PE: 3.7mm
- Colour: Dark blue

1.5 METRES	Cat. WA-1070	$11.95
2.5 METRES	Cat. WA-1072	$14.95
5.0 METRES	Cat. WA-1076	$19.95

40/80W SOLDERING IRONS



40 WATT MODEL

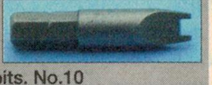
Cat. TS-1475 **$24.95**

80 WATT MODEL

Cat. TS-1485 **$29.95**

SNAKE EYE SCREWDRIVER BIT

NEW



Another of those odd shaped screwdriver bits. No.10

Cat. TD-2033 **$12.95**

AA FLAT NI-MH BATTERY

These are the flat batteries used in the really thin celluar telephone batteries. Rated 1.2V 650mA Ni-MH. Japanese cell Dimensions: 47mm(L) x 14mm(W) x 7mm(H).

NEW

Cat. SB-2435 **$11.95**

AMAZING VIDEO CAMERA LENS SCOOP!

We have made a sensational scoop purchase of a limited amount of video camera tele-converter lenses. SAVE A FORTUNE ON NORMAL PRICES!!! These are currently selling at Camera stores at prices up to $179. These lenses are reversible 2-in-1 types, 1.5X telephoto and 0.6X wide angle. One year warranty.

NEW

BELOW HALF PRICE

My camcorder has a zoom lens, why do I need an additional lens?

Sometimes, especially indoors, the camcorder lens does not have a wide enough angle to allow you to fit a large group of people or an entire setting into your shot. Alternatively, when outdoors, shooting sports or nature, you often require additional telephoto magnification to get close to the action. As you are likely to encounter both of these situations in the course of your shooting, the easiest answer is a reversible 2-in-1 lens. When you need to get closer to the action, attach the telephoto end of the lens to your camcorder. 1.5x telephoto magnification will bring you 50% closer to your subject. If you require a wide angle shot simply reverse the lens - the 0.6X wide angle will increase your field of view by 60%.

2 SIZES AVAILABLE:- This reversible 2-in-1 lens is available to fit both the Sony type micro camcorders and the standard size camcorder. They are lightweight, with specially coated optics to ensure correct colour balance and crisp images. Both come with adaptor rings to make compatible with a range of camcorder brands.

SMALL SIZE: Fits small camcorders, including Sony micro, Hitachi, Sharp and many security cameras. Supplied with 52 - 37mm adaptor ring.

Cat. QL-3420 **Only $59.95**

LARGE SIZE: Fits most standard size camcorders - Panasonic VHS-C, JVC, Sharp etc. Includes 3 adaptor rings; 58-52mm, 58-49mm, 58-46mm.

Cat. QL-3400 **Only $59.95**

SAVE UP TO $119!!!

Each lens is supplied with various adaptor rings to suit lens sizes

6.5mm PATCH CORDS

Set of 5 colour coded patch leads. Stereo 6.5mm plug on each end (O.K. for mono). Length 200mm. Cable is shielded.

Cat. WA-1054

Retail $14.95 Pkt 5

Now $6.95 Pkt 5

NEW **Save $8**

100 WATT 240V TO 115V STEPDOWN TRANSFORMER

NEW

AMAZING PRICE BREAK THROUGH Our previous lowest priced stepdown was $74.95 for a 65 watt unit. This one is only $49.95 for 100 watts. Includes overheat protection! When the unit gets too hot, the thermal fuse will open, then close after unit cools down restoring operation. Comes in plastic case & 240V lead.

Cat. MF-1091 **ONLY $49.95**

CAMCORDER BATTERY CHARGER

NEW

Charge your 6V, 7.2V and 9.6V camcorder batteries from your cars power with this charger. Charges Sony, NP-22, NP-55 and NP-77 and JVC, VHS-C, NBP-7/8 and BNC 6/7 types. These cover most common camcorder batteries. Also can be used as a power supply to run the camcorder from the car battery. Reduces car voltage to 6, 7.2 or 9.6V. Supplied with car cigarette lighter lead and output lead to camcorder with 4 different plugs to suit most camcorders and carry pouch. Cat. MB-3522

Retail Price $49.95 Save $20 Our Price $29.95

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

SCART LEAD

Scart plug to scart plug lead. Flat cable length 1.5mtr.

Retail Price $40.95

Our Price $17.95

Save $23 NEW

Cat. AV-6550

PHOTO FILE ORGANISERS NEW

Distress stock purchase. Way below normal prices these quality made in USA cases allow you to organise, store and protect photographs and negatives. They will store photos sizes 3.5" x 5", 4" x 6" and 5" x 7" as well as negatives. They have moveable plastic dividers and paper index cards and are dust proof, water resistant and archival safe. Will also hold CD's and cards etc. Supplied with convenient organisational labels. TWO SIZES AVAILABLE

SMALL

Holds up to 600 photos. Size 220(W)x185(H)x215(D)mm

Retail Price $29.95

Our Price $14.95

Save $15 Cat. HB-5200

LARGE

Holds up to 1400 photos. Size 450(W)x185(H)x215(D)mm

Retail Price $49.95

Our Price Only $29.95

Save $20 Cat. HB-5202

COLOURED DISKS NEW

Pack of 25 x 3.5" high density IBM formulated disks in 5 different colours. (5 x blue, 5 x pink, 5 x yellow, 5 x white and 5 x green). 100% error free. **PACK OF 25**

Cat. XC-4742

Only $16.95

MAGNETIC EARPHONE

2.5mm plug with 1 mtr. cord.

Only $1.95 NEW

Cat. AS-3302

1/8" CABLE CLAMPS

Cable clamps suits cable with dia of 1/8" or 3.2mm. Pkt.10

Only $1.25 NEW

Cat. HP-0750

AC/DC VOLTAGE DETECTOR NEW

Detects voltage, tests continuity and polarity.

Voltage - Hold next to plug, socket or cable. LED flashes and buzzer sounds if AC voltage is detected.

Continuity - Uses your body for checking continuity. LED and buzzer signal if there is continuity.

Polarity Touch anode with finger, cathode with tester. LED and buzzer signal if probe touched positive terminal.

Car battery Touch one terminal with finger, the other with tester. LED and buzzer signal if probe touched positive terminal. Cat. QP-2250

Retail Price $24.95

Save $18.00

Our Price $6.95

ADAPTOR PLUG NEW

2.5mm stereo plug to 3.5mm stereo socket.

Our Price $2.95

Cat. PA-3588

SEALED LEAD ACID BATTERY CHARGERS

Fully automatic. They switch to trickle charge automatically when battery is charged. LED indicator has different flash rates to adivse when battery is charged. These deliver 100% full charge batteries.

6V charger 500mA	12V charger 350mA
Cat. MB-3516	Cat. MB-3517
$29.95	$29.95

NEW

36V CT 150mA X'FORMER NEW

240V primary. 36V CT 150mA Cat. MM-2011

Only $5.95

CD CLEANING PAD NEW

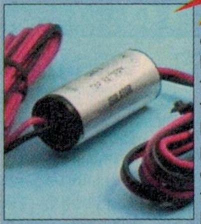
Chamois cloth on a round pad safely removes dust/dirt from compact discs.

Retail Price $5.95

Our Price $3.95

Save $2 Cat. AR-1475

CAR BATTERY ISOLATOR NEW



Allows a car alarm backup battery to be charged from the car battery and prevents it from draining back to the car battery.

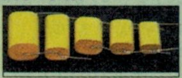
Retail Price $9.95

Our Price $5.95

Save $4.00 Cat. AA-3090

QUALITY METALLISED POLYPROPYLENE X'OVER CAPS

The RT (axial) bi polar capacitors are ideal for high quality x/overs. They offer excellent audio frequency characteristics, and are rated at 250 volts.



Value	Price	Cat.No.	Value	Price	Cat.No.
1uf	$1.95	RY-6950	5.6uf	$6.95	RY-6955
1.5uf	$2.50	RY-6951	6.8uf	$7.95	RY-6956
2.2uf	$3.50	RY-6952	8.2uf	$9.95	RY-6957
3.3uf	$4.50	RY-6953	10uf	$10.95	RY-6958
4.7uf	$6.50	RY-6954			

5" 4Ω HONEYCOMBE MIDRANGE

5" sealed midrange with aluminium honeycombe cone and cloth edge. Power handling 25 watts, 5.4oz. magnet, 4oz. impedance, frequency 600 - 7kHz approximately.

Retail Price $29.95

Save $15 Cat. CM-2086

Our Price $14.95 NEW

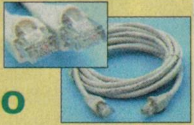
12V SLA BATTERY CHARGER BARGAIN

240V plug in charger delivering 12V DC at 150mA for charging sealed lead acid batteries. Output is to a cigarette lighter plug.

Only $9.95 NEW

Cat. MB-3512

CAT 5 NETWORK LEADS



RJ45 to RJ45 leads in office grey colour. Austel approved.

Cat. PL-0770	1 Metre	$8.50
Cat. PL-0772	3 Metre	$12.95
Cat. PL-0773	5 Metre	$16.95

NEW

UB14 PLASTIC CASE NEW

Plastic utility box with aluminium front and rear panels. Features removeable front/rear panels, PCB mounting ribs and rubber feet. Colour - beige. 110(W) x 140(L) x 46(H)mm.

"D" size battery shown for size

Limited quantity. Cat. HB-5950

Retail Price $17.95 Save $5

Our Price $12.95

BELDEN HIGH QUALITY 75Ω COAX CABLE NEW

DOMESTIC RG-59, Belden 9275. OD 6 mm Cat. WB-2002	HEAVY DUTY RG-6, Belden 9116 OD 7mm Cat. WB-2008
	
$1.25/metre	$1.75/metre
$152/152m roll	$1.50/m - 50m +

SCART LEAD NEW

Scart plug to 2 x BNC plug and 4 x RCA plugs. Length 1.5mtr.

Retail Price $42.95

Our Price $24.95

Save $18.00

Cat. AV-6552

AUDIO LEAD

NEW

3.5mm mono plug to 3.5mm mono socket. Plug and socket are all metal with springs. Cable is 5 mtrs. long and is a shielded audio cable, suitable for both microphone leads and speakers.

Only $2.95 Cat. WA-1021

GOLD SPEAKER CRIMP PINS

NEW

Packet of 4 crimp pins for easy termination of speaker cable to push speaker terminals. Inside diameter for cable is 3mm.

Retail Price $5.95
Our Price $3.95
Save $2.00 Cat. PT-4570

CD PROTECTION KIT

NEW

New formula spray will clean and repair minor scratches on your CD's or laser discs. Includes 30cc spray pack & ultra fine cleaning cloth.
Cat. AR1495

Retail Price $20.95
Save $12
Our Price $8.95

SPADE LUG ADAPTOR PACK

NEW

Allows you to connect together up to 2 female and one male spade lugs.
Cat. PT-4510
Only $1 Pack 10

CASSETTE HEAD CLEANER TAPE

Cassette player heads need cleaning regularly. Grab a couple of these and never have to worry about head cleaners again. Tape supplied in a plastic bag. No case supplied.

NEW

Cat. AR-1460
Normally around $3.95ea
Only 2 for $1

DUAL IMPEDANCE MIC

Uni-directional dynamic microphone. Dual impedance 500Ω or 50kΩ. Ideal for public address, singing and tape recording.
Frequency 60 - 14kHz
Sensitivity 500Ω - 72dB 50Ω - 52dB
Supplied in vinyl case with lead and holder. Cat. AM-4084

Retail Price $49.95
Our Price $29.95

UHF/VHF SIGNAL SEPARATOR/COMBINER

NEW

Allows you to either mix together or separate a UHF signal and VHF signal. Ideal if you have a UHF antenna and a VHF antenna, a TV with one combined input, or visa versa. Cat. LT-3028

Only $5.95

VIDEO CASSETTE RELABEL TAPE

NEW

Scotch brand 20mm diameter paper tape with sticky back. Made for sticking on the edge of video cassettes and boxes for titleing. Simply stick over old label. 17mtr. roll.

Only $2.50
Cat. AR-1490

HEADPHONE PADS

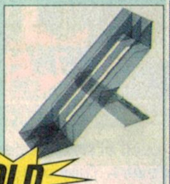
Pkt. of 2 - 50mm diameter foam replacement headphone pads.

NEW

Only $1.95 Pkt 2
Cat. AA 2012

BLAST FROM THE PAST LP RECORD STAND

Holds 30 LP records



Retail Price $10.60
Our Price $1.50
Save $9.10
Cat. AR-1483

OLD

Balun Bonanza!

Indoor 300Ω/75Ω balun. 75Ω coaxial socket to spade lugs.
Normal price would be $3.25 Cat. LT-3019
Only $1.50ea
10 for $10

NEW

CORD GRIP CLAMPS

Use on fig.8 cable. (A packet of 4 for round cable costs normally $1.40)

NEW

Pkt 10 - 11mm Fig. 8 Cat. HP-0720 **$1.50**
Pkt 10 - 10mm Fig. 8 Cat. HP-0721 **$1.50**

MAGNETS

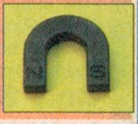
NEW

Educational magnets. Ideal for hobbyists and children to learn more about magnetism. Individual magnets are difficult to find

BAR MAGNET Size: 70(L) x 12(W) x 5(D)mm. Each end marked with N / S.

Cat. TH-1874 **75¢ ea**

U SHAPED MAGNET
Size: total 30 x 30mm. Each end marked with N / S.
Cat. TH-1873 **75¢ ea**

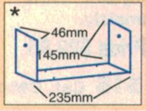


SPEAKER MOUNTING BRACKETS

NEW

Designed for mounting a speaker box to a wall. Problem is, the speaker box needs to be the same size as these brackets!!! Consists of two steel brackets, dimensions as per diagram*, two 3mtr. lengths of fig.8 speaker cable, 4 bolts with knobs for screwing into non existant speaker, 4 pieces of sticky one side felt to avoid scratching non existing speaker and 8 x 4mm dia. x 35mm bolts, nuts and washers.

Definately worth $3.95
Cat. CW-2800



$3.95 The Lot

VIBRATION DETECTOR SWITCH

Tamper proof vibration detector switch. Adjustable vibration 5 - 20g. Rated 0.1A/50VDC. Use only with NC loop or circuit.
Cat. LA-5088
Retail Price $9.15 Save $5.20
Our Price $3.95

NEW

MICRON PIR MADNESS CONTINUES!!!

In April we advertised a quantity of these detectors, as a scoop purchase deal. They sold so well, and work so well, we are now direct importing them, and can continue to offer these at the previous low price. We even have different lenses available
The Micron is the ultimate low cost/high performance PIR detector. The Micron circuit design has been tested at 20V/m over the frequency range 20 to 1000MHz proving that the Micron has ultra high RFI protection and complies with BS6667, part 3 and IEC Publication 801, Part 3. Knowing the Micron has passed these tests and by utilizing the selectable 1,3 or 5 pulse count, once installed correctly you can leave the installation, confident that false alarms will not occur.
Specifications: •selectable 1, 3 or 5 pulse count •operating voltage 9-16VDC •current 17mA •alarm contacts - NC •operating temp -10° to 55°C •pyroelectric detector dual element.

Cat. LA-5030 **ONLY $25 OR 10 FOR $200**

Long Range Lens	Cat. LA-5031	$4.95
Curtain Lens	Cat. LA-5032	$4.95

Installers Contact our wholesale department for great quantity prices

KEEP THE CAT OFF THE LOUNGE

with TATTLE TALE VIBRATION ALARM

NEW

Using structural vibration technology, the TATTLE TALE can detect vibration in an object or surface without any apparent motion. Tattle Tale sounds a distinct 3 second alarm. Features include:- •Automatic alarm reset with high/low sensitivity switch. •long life continuous operation with a single battery. •works in any position; hang it, set or place it anywhere. Pet training:- Keeps pets off - •furniture •counter tops •beds •cars etc etc, prevents scratching, clawing and climbing. Security:- Place or hang TATTLE TALE to detect tampering of: •doors •windows •cabinets •drawers •gates or any "off limits" areas. Made in U.S.A. Operates off 9V battery (not supplied). Size:- 126mm(L) x 55mm (W) x 34mm (D)

Cat. LA-5270 MADE IN U.S.A. **$39.95**

Construction Project:

'VALVE SOUND' PREAMPLIFIER

This easy to build, low cost valve stereo preamplifier lets you hear valve 'sound'. You can adjust the overload level as shown by on-board LED indicators to get the right amount of valve overload sound. The gain is adjustable, so you can connect the amplifier to any sound system, with or without distortion effects.

by PETER PHILLIPS

Valve amplifiers have never really gone away, despite the overwhelming popularity of solid state amplifiers. Keith Howard, in an article in the July '95 edition of the UK magazine *The Gramophone* writes, by way of explanation of this phenomenon: "All contrary technical arguments not withstanding, a significant proportion of critical listeners have discovered that they prefer the sound of valve electronics. That, and only that, has enabled the valve's survival". The article goes on to demolish the usual technical reasons pundits give to explain why valves sound better.

In a companion article *The sound of cables*, in the August '95 edition of *The Gramophone*, Howard refers to objectivist and subjectivist opinions. An objectivist, according to Howard, "Holds the view that the audible characteristics of hifi equipment can be completely defined by laboratory measurements." On the other hand a subjectivist "...argues there's more to music reproduction than the figures revealed by a THD meter and an oscilloscope."

Whatever view you hold, there's no doubt valve amplifiers are preferred by a lot of people, many of whom are happy to pay a lot of money for the privilege. Today, a wide range of commercial sound equipment has a valve preamplifier, including audio amplifiers, guitar amplifiers, even professional quality studio microphones.

You can also buy all-valve (includes valve output stage) audio and guitar amplifiers. The problem here is limited output power, typically no more than 50W per channel. As well, the cost of this equipment is around 10 times the cost of an equivalent solid state power amplifier. So there's got to be something in it, as not all purchasers of valve amplifiers are wealthy purists with nothing better to spend their money on!

For example, many guitarists prefer an all-valve guitar amplifier, or at least one with a valve preamplifier. The usual reason is a preference for the sound a valve amplifier gives when overloaded, a sound pop guitarists often exploit to great effect.

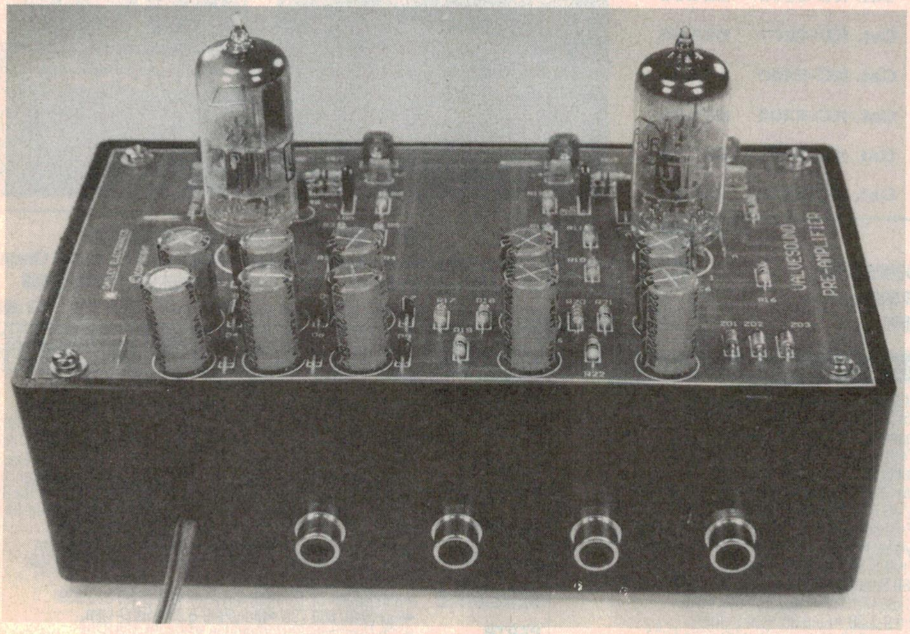
This project, from Oatley Electronics, is a stand-alone valve stereo preamplifier, based on 6J6 twin triodes, with one valve per channel. It operates from a 12V AC plugpack and the highest voltage in the circuit is around 70V. It has built-in overload indicators so you can adjust the degree of overload and therefore the distortion level. The complete amplifier and its power supply are on one single-sided PCB that mounts on a plastic utility box.

Before we describe the circuit and its construction, let's have a look at some of the technical reasons that are often given to explain why a valve amplifier 'sounds better'.

Valve sound

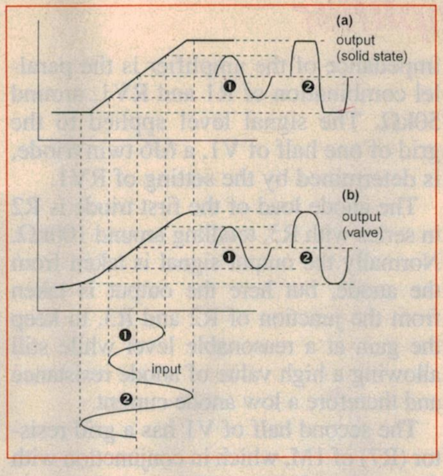
Many people claim that a valve amplifier sounds warmer and fuller than a solid state amplifier. There's considerable agreement that this is because of the different ways that valve and a solid state amplifiers overload. The argument runs along these lines: solid state amplifiers tend go into overload quite suddenly, while a valve amplifier starts limiting, or squashing, the signal before running out of headroom.

According to John Simonton, in an article describing a valve preamplifier in the June 1994 edition of *Electronics Now*: "Both of these responses produce harmonic distortion, adding frequency components that were not in the original signal; but squashing generates much lower order harmonics. The result doesn't have the



This all-valve stereo amplifier is powered by a 12V AC plugpack. Build it and check out the 'valve sound'.

Fig.1: A transfer curve shows how an input signal is transferred to the output. A solid state amplifier (a) is linear over most of its range before it suddenly 'tops out', giving severe clipping at overload. A valve amplifier (b) is not as linear, so overload occurs more gradu-



'buzzy fuzziness' that comes from the high frequency components produced by clipping. If the squashing is asymmetrical (more on the top than on the bottom, or vice versa) the result can be strong second and fourth order overtones. These are musically benign in terms of producing dissonance, and more pleasing (though not necessarily more interesting) than the odd harmonics of clipping."

He continues with a few more comments about the nature of sound and perceived volume, claiming: "All natural instruments generate an increasingly complex harmonic structure when they're played louder. They don't just produce higher sound pressure levels — in a very real way they get 'fuller'. In fact, the increase in harmonic complexity gives the strongest indication that one sound is louder than another. The squashing distortion of valves extends this same principle to amplifiers." Simonton suggests this might be why valve amplifiers are often subjectively judged to be 'louder' than solid state counterparts.

On the other hand, Keith Howard makes the rather obvious point that if an amplifier is in overload, you need a more powerful amplifier. True — but regardless of the output power, overload can still occur. Because the overload sound of a valve amplifier is more harmonious than for solid state, it makes sense to have a valve preamplifier that acts as a limiter for the rest of the amplifier. That way, if there is overload, at least it's not as objectionable as the sound from a clipped output stage.

The graphs in Fig.1 illustrate why the overload characteristics of a solid state amplifier are different from those of a valve amplifier. In (a), the linear transfer curve of a solid state amplifier causes the output to clip sharply when the level of the input signal exceeds the capability of the amplifier. According to Fourier, a 'discontinuity' such as clipping produces a spectrum of harmonics that extend into and beyond the audible range. In a musical context, the resulting odd harmonics create a strong dissonance.

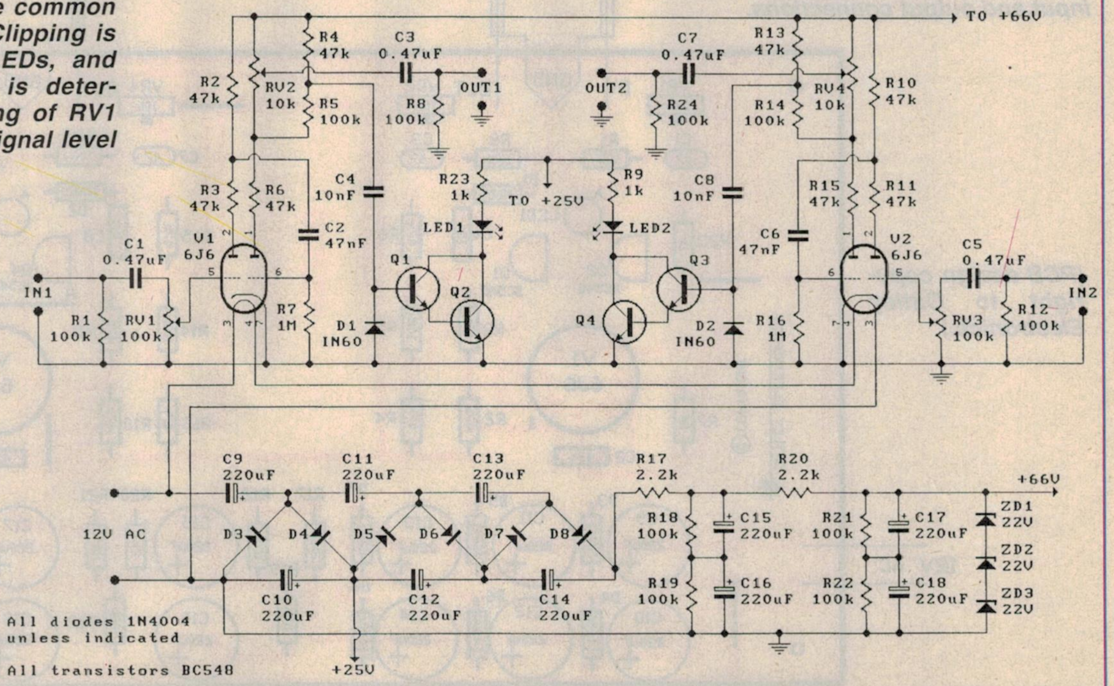
As you can see in Fig.1(b), there are no discontinuities in the overload characteristics of a valve amplifier, instead there's a 'rounding off' effect at the top and bottom of the output signal. Because of this, the harmonics are within a few octaves of the fundamental, which, according to Simonton, can actually decrease the total harmonic content. This can be shown by applying a triangular wave to a valve amplifier. Under overload conditions, the output signal looks more like a sinewave, as the odd harmonics have been suppressed.

Of course, you might react to this by arguing that if the transfer curve of a valve amplifier is non-linear, then surely this means the output is distorted, even if there's no overload. Interesting, isn't it?

Regardless of the arguments, there's still a strong preference for at least a valve preamplifier stage in an amplifier. This project will let you do your own experimenting and help you form your own opinion. If you like the sound (assuming you can hear a difference), then connect this unit into your sound system. If you can't hear a difference, at least you have a neat little valve preamp that will be a discussion point with friends.

Guitarists will be especially interested in this project, as it provides a way of adding a valve stage to a guitar amplifier. Adjusting the overload characteristics of the amplifier will give some interesting effects that are likely to be more musical than those from an overloaded transistor amplifier...

The circuitry around each valve is a two stage common cathode amplifier. Clipping is indicated by the LEDs, and the clipping level is determined by the setting of RV1 (RV3). The output signal level is set by RV2 (RV4).



'Valve Sound' Preamplifier

Now we'll look at the circuit.

Circuit details

The circuit is in three parts: the power supply, the left channel and the right channel amplifiers. Both amplifiers are identical, so we'll describe the circuit around valve V1. If you are not sure how a valve works, regard it as a FET, in which the voltage applied to the input element determines the current flowing through it.

For a valve, the input element is called the *grid*, so named as it is generally made of a grid of fine wire. Electrons are emitted from the cathode, a specially coated cylinder surrounding a heating element called a filament. The electrons 'boiled' off the cathode are attracted by the positive potential on the anode, and the number of electrons reaching the anode (and therefore the current through the valve) is determined by the voltage on the grid. As in a FET, the output voltage is 180° out of phase with the input signal, assuming the input is to the grid and the output from the anode.

Like a FET, a valve has a mutual conductance (gm), which is a figure relating to its gain. The 6J6 valve used in this amplifier has a gm of 5.3mA/V and an amplification factor of 38.

Because the input impedance of a valve is virtually infinite, the input impedance of the amplifier is the parallel combination of R1 and RV1, around 50kΩ. The signal level applied to the grid of one half of V1, a 6J6 twin triode, is determined by the setting of RV1.

The anode load of the first triode is R2 in series with R3, totalling around 100kΩ. Normally the output signal is taken from the anode, but here the output is taken from the junction of R2 and R3, to keep the gain at a reasonable level while still allowing a high value of anode resistance and therefore a low anode current.

The second half of V1 has a grid resistor (R7) of 1M, which in conjunction with the required frequency response (or upper cutoff frequency), determines the minimum value of coupling capacitor C2. The anode load resistance of the second triode is the combined resistance of R4, R5, R6 and RV2, which for practical purposes is around 56kΩ. The output of the amplifier is taken from the wiper of RV2, which is in effect the volume control. RV1 is set to give the required amount of distortion, as indicated by LED1.

The LED indicators are a form of solid state VU meter. The values of R4 and R5 have been chosen to give a visual indication of overload when the input at the grid of the first triode is about 100mV. At this input voltage there will be a small amount of non-linearity in the output, which increases dramatically as the input signal level rises.

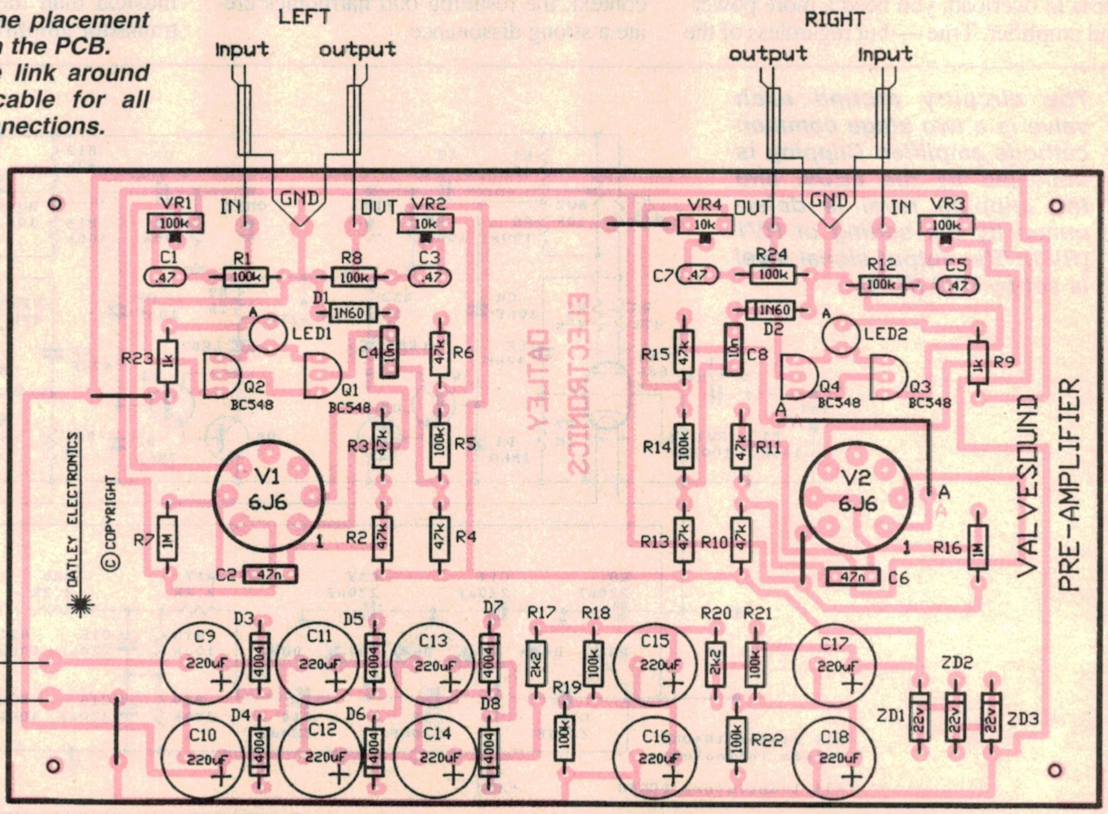
Transistors Q1 and Q2 form a Darlington pair to drive LED1. The input signal is supplied through C4, with a charge path via the base of Q1 and a discharge path through germanium diode D1. A germanium diode is used to give the indicator a high sensitivity.

The power supply comprises a voltage multiplier and RC filter. The multiplier section is fed with 12V AC, and through the multiplying action of C9 to C14 and D3 to D8, produces about 75V at the cathode of D8. The RC filter network of R17 to R22 and C15 to C18 is necessary to get rid of any ripple in the DC applied to the circuit. The output of the filter is regulated to 66V by the series string of zener diodes, ZD1 to ZD3.

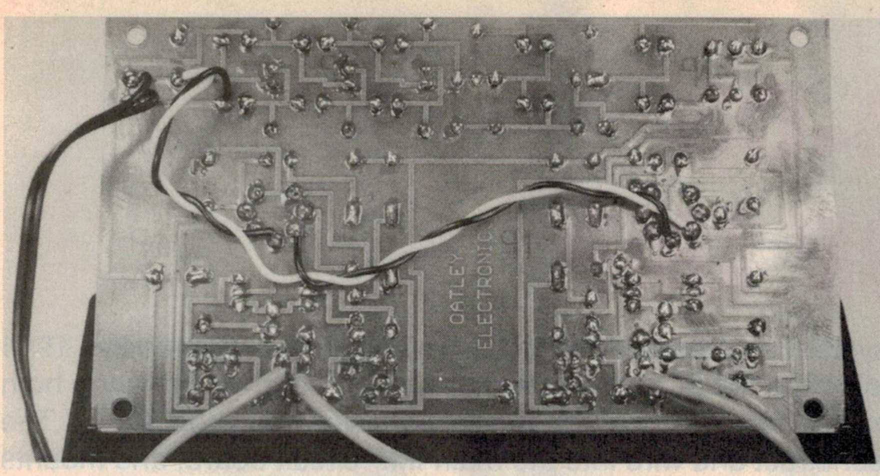
Incidentally, the voltages in this amplifier are relatively low, to get a valve 'sound' more easily. Most valve amplifiers operate at several hundred volts, which is not only more hazardous, but requires expensive high voltage components.

The low voltage exaggerates the non-linearity inherent in all valve amplifiers, due to the 'space charge' effect, in which electrons from the cathode accumulate around the grid instead of being attracted to the anode. This causes the grid voltage to become negative, which

This layout shows the placement of all components on the PCB. Note the right angle link around V2. Use shielded cable for all input and output connections.



(PCB design copyright to Oatley Electronics.)



This photo shows the track side of the PCB and the filament wiring. The elements are in series, so pin 3 of V1 goes to the 12V AC supply, pin 4 (V1) to pin 3 of V2, and pin 4 (V2) to the AC supply. Twist the wires together as shown to minimise hum.

in turn prevents more electrons reaching the anode. The space charge effect varies with the signal voltage at the grid, giving non-linearity that varies with the input signal level. It also means the valves are 'self-biased', which explains the absence of cathode resistors.

Construction

All components, including the valves, mount on a printed circuit board. In general, construction is simply a matter of stocking the PCB with the components as shown in the layout diagram. However there are a couple things to note.

The first is the valve filament wiring. The filaments are internally connected to pins 3 and 4 of the valves, and are rated at 6.3V. To minimise hum and other noise, the filaments are not connected to PCB tracks, and are therefore hardwired with hookup wire as shown in the photo.

The filaments are connected in series across the incoming 12V AC from the plugpack. Connect pin 3 of V1 to the 12V AC, pin 4 of V1 to pin 3 of V2, and pin 4 of V2 back to the 12V AC. Twist the filament wires together to minimise hum. The wiring solders directly to the PCB pads.

The next point is the valve 'sockets'. Those supplied with the kit are 1mm matrix pin sockets, which need modifying so they can be inserted into the PCB. Using suitable pliers, cut and form the solder end of the sockets so they can fit into the PCB holes. Then fit a socket to each pin of the valve, and adjust them so they fit into the PCB. Then solder the sockets to the PCB. Do this for each valve.

There are five wire links to fit, including one formed into a right angle, around V2. Take particular note of the orientation of the diodes and electrolytic capacitors. Also make sure the LEDs are mounted the right way round. The LEDs should be about 5mm away from the PCB.

The wiring to the input and output RCA sockets is done with shielded cable, soldered as shown in the layout diagram. In the prototype, RCA sockets were fitted to the side of the plastic case holding the PCB. The 12V AC supply was passed through a hole drilled in the case, and the leads soldered to the PCB on the trackside.

Testing

When you're sure construction is complete, apply power to the circuit. You should see the valve filaments light, and after about 30 seconds the valves should have 'warmed up' and the amplifier should be ready to go.

As a quick check, measure the voltage at the cathode of ZD1 to confirm it's around 66V. Then check the anode voltages of each valve. On the prototype, the voltage at pin 1 was around 25V, at pin 2 between 12V and 20V.

PARTS LIST

Resistors

(All resistors 1/4W)

R1,5,8,12,14,18,19,21,22,24	100k
R2,3,4,6,10,R11,13,15	47k
R7,16	1M
R9,23	1k
R17,20	2.2k
RV1,3	100k vert. trimpot
RV2,4	10k vert. trimpot

Capacitors

C1,3,5,7	0.47uF monolithic
C2,6	.47nF polyester
C4,8	.10nF polyester
C9-C18	220uF 63V electrolytic

Semiconductors

ZD1-3	22V 330mW zener
LED1-2	5mm red LED
D1-2	1N60 germanium signal diode
D3-8	1N4004 400V diode
Q1-4	BC548 NPN transistor

Miscellaneous

2 x 6J6 twin triode valves; PC board, 90 x 153mm; 14 x 1mm matrix board clips for valve sockets; 12V AC 500mA plugpack; 4 x RCA sockets; plastic utility case 160 x 95 x 50mm; shielded cable, hookup wire.

Kit available:

A kit of parts for this project is available from Oatley Electronics, of PO Box 89, Oatley NSW 2233. Phone (02) 579 4985, fax (02) 570 7910. Price of the kit, including all components, PCB, plugpack and case, is $60.

Apply a signal (1Vp-p or so) to the inputs and confirm that adjusting RV1 and RV3 causes the LED indicators to light. If the applied signal is less than 100mV, these indicators won't light, regardless of the setting of RV1 (RV3). Unless you want the distortion effect, adjust RV1 (RV3) so the LED indicators are extinguished. Monitor the signal at the output, and adjust the overall gain of each amplifier with RV2 (RV4). The maximum voltage gain of the amplifier is around 36, but in many cases you'll want a gain of unity.

Using the preamp

How you connect the preamp to an existing system will depend largely on what you want to do with it. In an audio system, you could connect it in the tape loop of the main amplifier, or simply use it as a preamplifier for one piece of sound equipment, such as a CD player. In this case, connect the CD player to the valve preamp, and the output of the preamp to the CD input of the sound system. Adjust the gain of the valve unit to suit.

For a guitar amplifier, try connecting the guitar directly to the valve preamp, with its output in turn connected to the usual input of the guitar amp. If the signal level from the guitar is not enough to cause the LED indicators on the valve amp to light, you might need to integrate it into the guitar amplifier, assuming you want the distortion effect.

That is, find a point in the guitar amplifier where one amplifying stage can be isolated from the next, with the valve preamp becoming the link between the two stages. This would normally be done at the front end of the guitar amp. You will obviously need to know what you are doing to avoid damaging the guitar amplifier.

You could also try removing resistors R1 (and R12 if you are using both channels) to increase the input impedance of the preamp, to make it more compatible with high impedance guitar pickups. To increase the input impedance of the amplifier even more, make RV1 (and RV3) a 1MΩ trimpot(s).

You could also integrate this unit into an amplifier of any type, perhaps one you've built yourself. The output impedance of the preamp is relatively high, so don't expect it to be able to drive an output stage directly. Instead buffer it with an emitter follower stage or similar. ❖

Construction project:

'MLS' ADD-ON BOARD FOR IMP

If you have an IMP audio testing system as presented in the July, August and September 1994 issues of *Electronics Australia*, adding the 'MLS' option board described here will enhance both the accuracy and speed of your measurements through its special precision noise test signal. The option board itself is quite easy to construct and wire into the main IMP circuit board, and mounts neatly inside the existing case using minimal hardware.

by ROB EVANS

For those unfamiliar with the series of IMP articles published a couple of years ago in *EA*, the Impulse response Measurement and Processing (IMP) system is a quite sophisticated PC-based audio test instrument formed around a dedicated hardware interface module and matching IMP software. The unit has caused considerable interest amongst those involved in audio testing at both an amateur and professional level, and as you may have noticed from the curves included in many of our audio-related articles since that time, has been a valuable addition to our own array of lab instruments here at *EA*.

In short, IMP uses a simple impulse as a test signal (hence its name), and has the ability to digitally 'record' how an audio device reproduces that stimulus over time. The recorded data is then passed to the host PC (via its parallel printer port), where IMP's software converts the information into the *frequency* domain using Fourier Transform techniques. The result is the frequency and phase response of the audio device under test.

Like any other testing system though, there is a direct relationship between how much raw data is collected and the breadth or accuracy of the final result. In IMP, this means that the response data must be collected over a reasonably long period — many times the duration of the test pulse — so that the Fourier Transform can provide sufficient low-frequency information. At IMP's lower sampling rate of 1.92kHz for example, the test pulse has a duration of 520us, while data is collected for around two seconds.

This in turn means that the *overall* energy of the recorded test pulse (during the data collecting period) is really quite low, and modest levels of residual or transient noise will tend to influence the final measurement. But since the noise is irregular by nature, IMP largely solves this problem by performing a number of sequential tests, then averaging the results.

All in all this averaging scheme works well, and the final results are quite clean when IMP's software is configured for a reasonable number of repetitive tests. In theory, each time the number of tests is doubled the signal-to-noise figure improves by 3dB, so averaging two tests provides a 3dB improvement, four passes improves the figure by 6dB, and so on.

The disadvantage of this type of averaging system, on the other hand, is the actual time it takes to complete a meaningful measurement and the environmental noise that can occur during that period. As you might typically configure IMP to average say 10 tests while using the 1.92kHz sampling rate (for a low-frequency plot), the total test time will be at least 20 seconds — a long time in which to maintain a quiet testing environment...

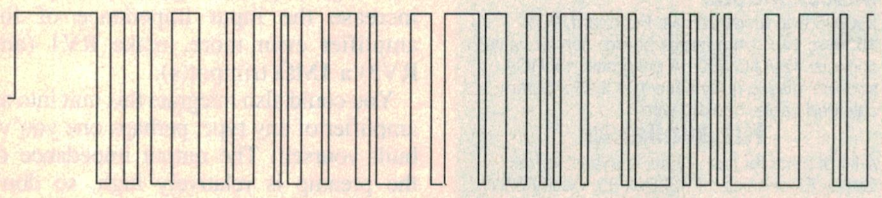


Fig.1: A section of the pseudorandom noise used as a test signal by the MLS option board

The Maximum Length Sequence (MLS) add-on board described in this article addresses the above measurement-time and noise intrusion difficulties by using just *one* burst of pseudo-random (or MLS) noise as the test signal. The recorded result from this single test is then converted to a conventional impulse response by the PC using a Fast Hadamard Transform, and that response in turn is resolved to a frequency and phase plot in the normal way.

While this appears to be simply performing the same function in a different (and more convoluted) manner, the intense structure of the MLS signal means that its *single* measurement is equivalent to a large number of conventional, averaged pulse tests. As a result, an MLS test procedure is completed in a very short time, and is effectively averaged by the number of pulses that are in the complex MLS signal. A measurement that normally takes more than say 20 seconds (as above) is completed in just a few seconds, with cleaner results.

As the core of this rather neat signal conversion trick is the structure of the MLS signal itself and the software-based Hadamard Transform. A simplified explanation of that process may be of value to those who are interested in the 'nuts and bolts' of the system.

MLS 'precision' noise

Despite the fact that IMP is designed to test the analog transfer function of the device under test (a loudspeaker, audio amplifier, and so on), the MLS test sig-

The IMP module as described in the July/August/September 1994 issues of EA. No external modifications are needed when upgrading to the MLS system, and the case has more than enough internal room to hold the additional circuit board.

nal itself has the structure of a digital pulse train with a seemingly random variation in the actual pulse width. This can be seen from the MLS waveform depicted in Fig.1, which shows a small portion of the actual test signal produced by the MLS board — the first 128 steps out of a total of 8192, as it happens.

The complete test signal is actually composed of two MLS noise bursts, where the first is used as a 'warm-up' run and each has a length of 4096 (4K) bits or steps. The key point here is that despite the apparent random nature of the digital 'code' contained in this 4096-length MLS signal, it is in fact quite well defined and is effectively 'known' by the software-driven Hadamard Transform used to convert the recorded data into a conventional impulse format.

Fig.2

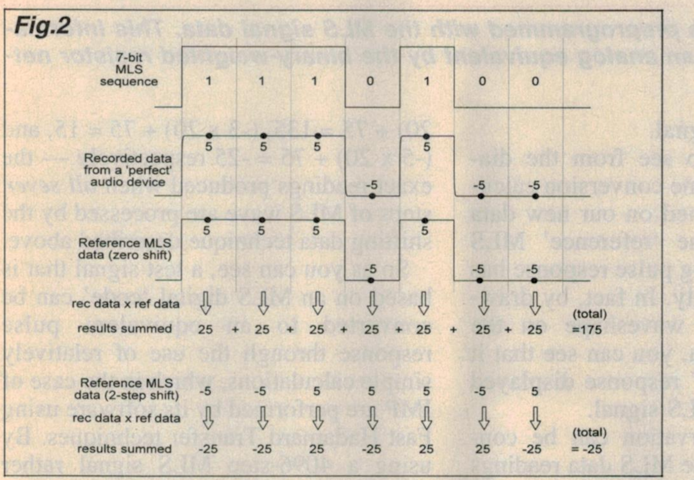
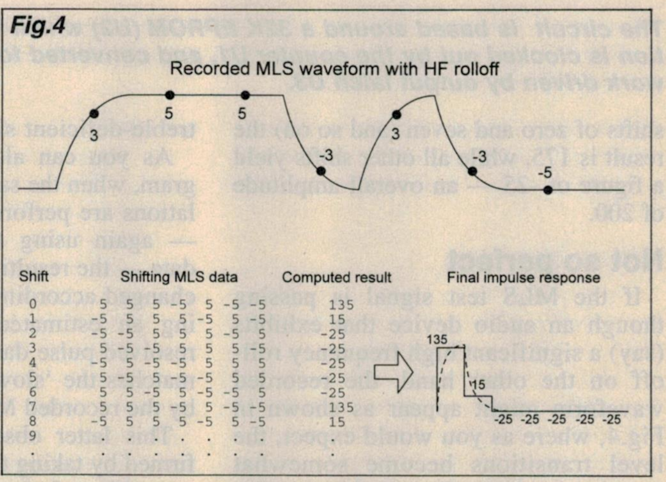


Fig.4



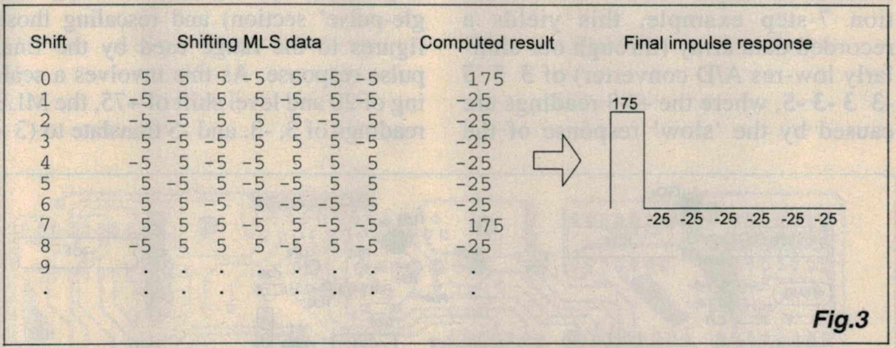


Fig.3

This relationship can be demonstrated by considering a maximum length sequence of seven bits, which would have a unique digital sequence of **1 1 1 0 1 0 0** — see Fig.2. If this MLS test signal was used to test an *ideal* audio device, the reproduced signal would reflect the same sequence of highs and lows, which when recorded via an analog-to-digital (A/D) converter — as is the case with IMP — might yield a data sequence of **5 5 5 -5 5 -5 -5**. Note that the A/D converter responds to bipolar signal levels, as is needed for AC-coupled audio signals.

The transform to an equivalent (single) impulse response can then be performed using the known MLS data sequence, which in data terms can also be **5 5 5 -5 5 -5 -5**. Note that the recorded data is the same, because the 'ideal' device under test does not change the shape of the signal.

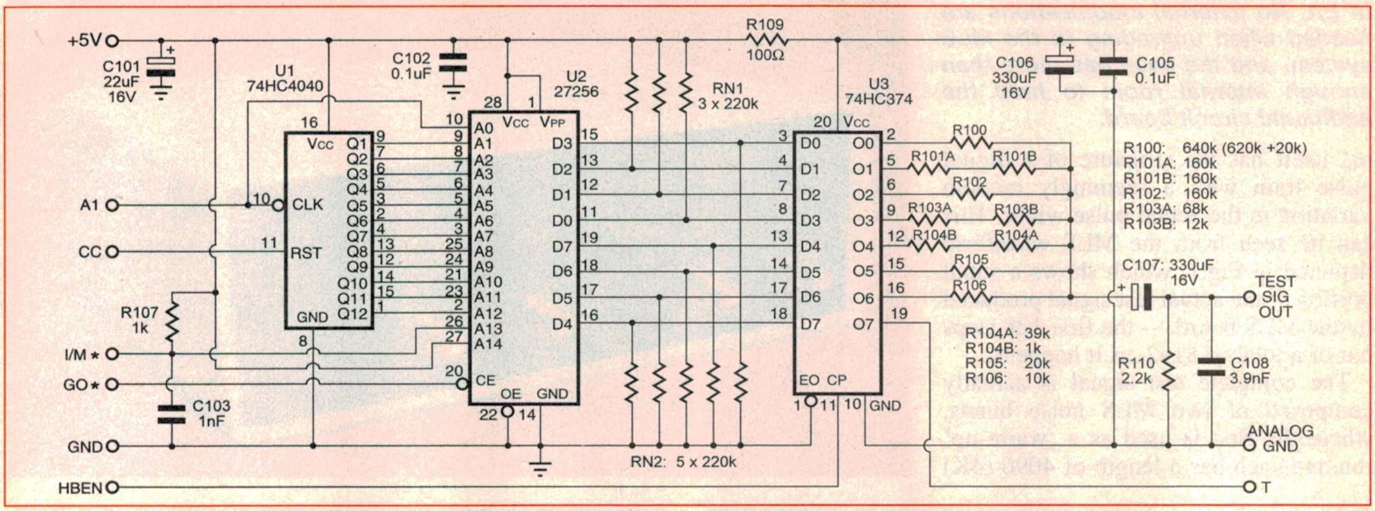
Now comes the interesting bit. If the seven data readings for the recorded signal are multiplied by the corresponding figures in the (known) MLS sequence, then the results summed, we arrive at a figure of 175: 25 + 25 + 25 + 25 + 25 + 25 + 25 — as shown in the diagram. However, if the same computation is performed with the MLS data sequence *shifted* by one or more (but not seven) steps, the result is -25.

When the reference MLS sequence is shifted two steps to the right for example, its data becomes **-5 -5 5 5 5 -5 5**, and when multiplied and summed with the recorded readings the results are;

-25 + -25 + 25 + -25 + 25 + 25 + -25 = -25. And since a shift of seven would bring the MLS data back to its original sequence, the computed result returns to 175, as above.

More than a full cycle of this process is shown by the data presented in Fig.3, where as you can see from the summed results, the data from a seven-step MLS test has been converted to the data for a seven step *pulse* response. Note that at

'MLS' Add-On Board for IMP



The circuit is based around a 32K EPROM (U2) which is preprogrammed with the MLS signal data. This information is clocked out by the counter U1, and converted to an analog equivalent by the binary-weighted resistor network driven by output latch U3.

shifts of zero and seven (and so on) the result is 175, while all other shifts yield a figure of -25 — an overall amplitude of 200.

Not so perfect

If the MLS test signal is passing though an audio device that exhibits (say) a significant high frequency roll-off on the other hand, the recorded waveform might appear as shown in Fig.4, where as you would expect, the level transitions become somewhat rounded in shape. For our low-resolution 7-step example, this yields a recorded data array (through our similarly low-res A/D converter) of **3 5 5 -3 3 -3 -5**, where the +/-3 readings are caused by the 'slow' response of the treble-deficient signal.

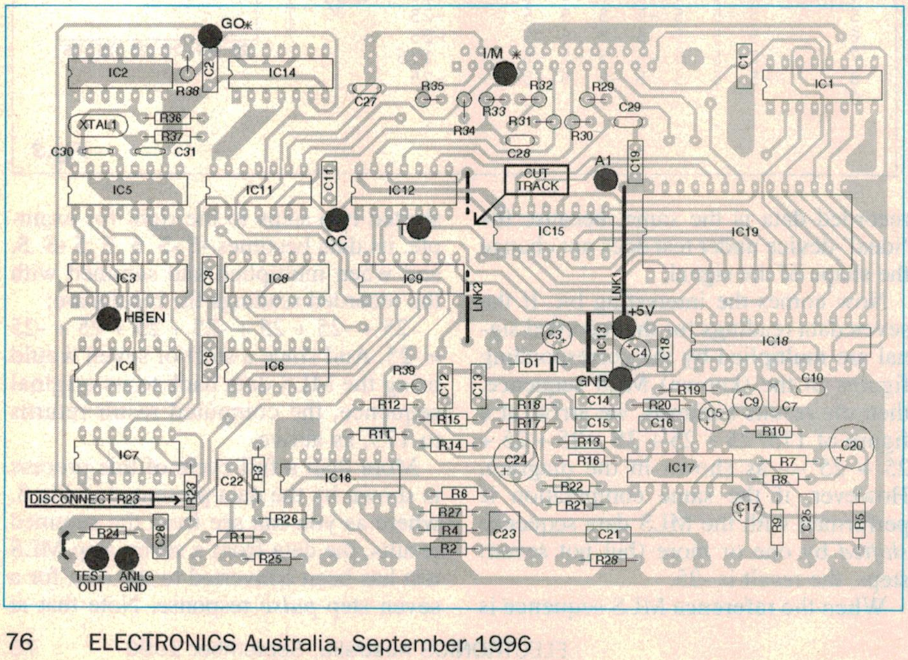
As you can also see from the diagram, when the same conversion calculations are performed on our new data — again using the 'reference' MLS data — the resulting pulse response has changed accordingly. In fact, by drawing an estimated waveshape on the resolved pulse data, you can see that it matches the 'slow' response displayed by the recorded MLS signal.

This latter observation can be confirmed by taking the MLS data readings at positions 5, 6 and 7 (in effect, a 'single-pulse' section) and rescaling those figures to the range used by the final pulse response. As this involves a scaling of 20 and level shift of +75, the MLS readings of 3, -3, and -5 translate to (3 x 20) + 75 = 135, (-3 x 20) + 75 = 15, and (-5 x 20) + 75 = -25 respectively — the exact readings produced when *all seven* steps of MLS wave are processed by the shifting data technique described above.

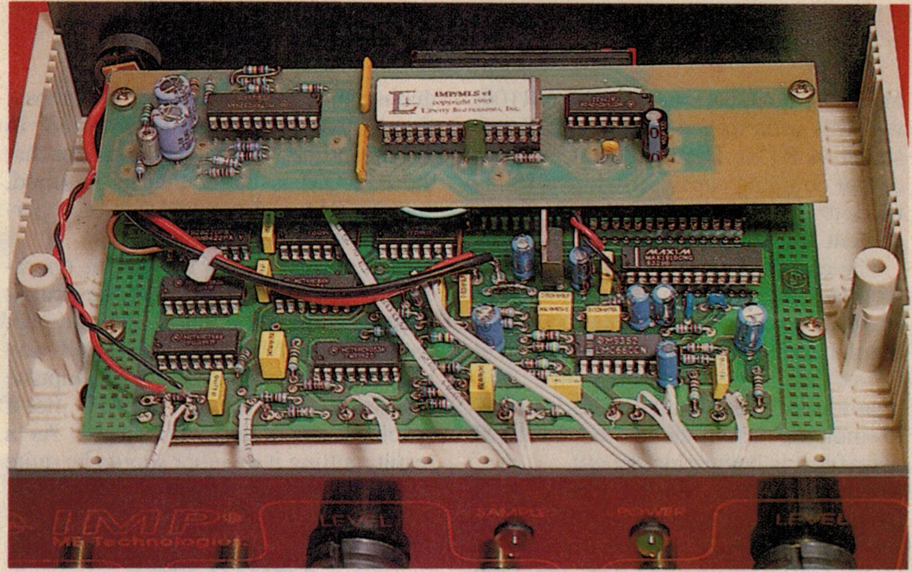
So as you can see, a test signal that is based on an MLS digital 'code' can be converted to an equivalent pulse response through the use of relatively simple calculations, which in the case of IMP are performed by its software using Fast Hadamard Transfer techniques. By using a 4096-step MLS signal rather than our simple 7-step example however, IMP's MLS option effectively averages the signal by a much higher degree and therefore offers a corresponding improvement in noise rejection.

If the general way in which this process reduces noise content still seems a little unclear, try considering how a transient interference signal might effect both a conventional pulse test and the MLS equivalent. With the conventional arrangement, the transient will simply add to the recorded pulse response in the normal way, and the following conversion to a frequency and phase plot will directly suffer from the effects of that aberration — though this would be normally reduced with averaged tests, of course.

With the MLS test signal however, the introduced transient will only effect a few steps in its overall length



IMP's circuit board showing the changes that must be made, plus the MLS connection points. Note that only the bottom (non-component side) tracks are shown, and you may need to drill PCB holes to gain access to the I/M*, +5V and GND points.



The MLS board mounts at the rear of the IMP case, and is supported by two threaded standoffs.

of 4095. When the data is then converted to an equivalent pulse response as detailed above, the effect is evenly spread over the entire duration of the signal. In turn, this very small error occurring through the complete pulse response translates to a minor discrepancy in the final frequency and phase plot — in practice, it would appear as insignificant background noise.

The MLS board

As with the IMP system itself, the MLS option board was originally developed by US-based engineer Bill Waslo of Liberty Instruments of Middletown, Ohio, and subsequently published as a project in *Speaker Builder* magazine — again in the USA. And as before, we have been able to present our own version of the project through the efforts of Peter Stein of ME Technologies, who negotiated the original arrangements with Liberty Instruments and as you might expect, can supply both kits and key components for the MLS option board and IMP itself.

The IMP software is — and has been for some time — compatible with the MLS test signal, and appears to take the additional MLS-to-impulse conversion routine in its stride. With the MLS option selected, the program behaves in an almost identical manner to when the conventional impulse system is operating, except of course that the test is completed in a shorter time and the results appear very clean indeed...

The MLS board itself is a relatively small assembly and has been designed to 'piggyback' onto the main IMP circuit board via threaded standoffs, while short lengths of hookup wire are used to pass signals between the two boards. Considering the relatively complex nature of the MLS signal and the amount of processing involved however, you may have noticed that both the board *and* its circuit are surprisingly simple. In short, this is mainly due to the fact that the circuit is based around a pre-programmed 27256-type EPROM (U2), which is used to store and 'transmit' the special 4096-length MLS test signal.

The MLS circuit

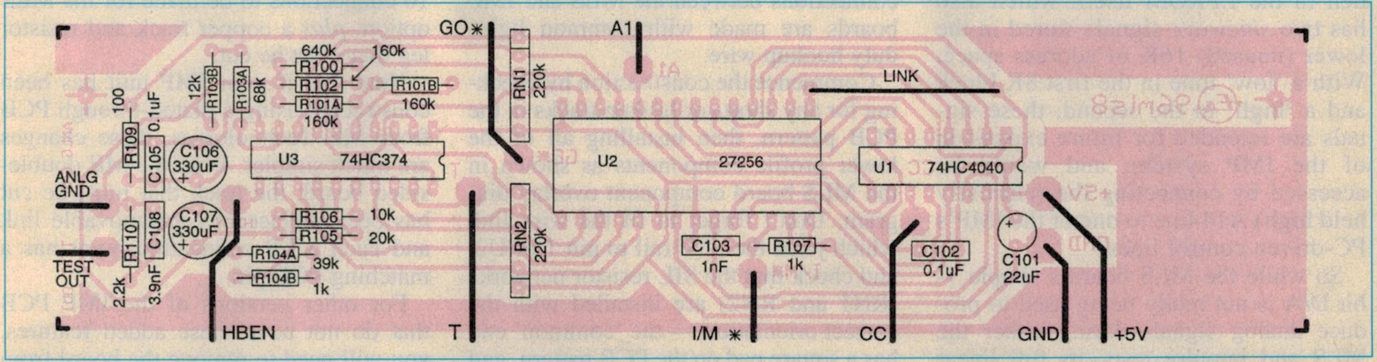
As you can see from the associated schematic diagram, the MLS board uses just two 'support' chips (U1 and U3) along with the abovementioned EPROM (U2). HCMOS 4040 counter U1 is used as a simple address counter to clock the EPROM through its MLS data stream, while the 74HC374 octal D-type flip-flop U3 is used as an output data latch.

In order to avoid getting bogged down in a detailed analysis of exactly when the various control lines (A1, CC, I/M, etc) are activated by the main IMP circuit however, we will simply assume that they happen at the *right* time for the purpose of this discussion. If you wish to gain a complete picture of the timing sequence involved, we would suggest that you refer back to the original series of IMP articles for details on the activity of these lines.

Getting back to the MLS circuit at hand, you can see that the binary-coded outputs from address counter U1 are tied directly to address lines A1 to A12 of the 27256-type EPROM (U2), while the lowest-order line (A0) is driven straight from U1's clock signal at pin 10. In sympathy with the clock signal applied at input line A1 then, U1 will count the 32K EPROM through 8K of its available address space when U1 itself is enabled by the CC control line (pin 11) and the EPROM is enabled by the GO* line (pin 20).

Assuming both chips are active, the eight bits of data corresponding to each EPROM address are then coupled from its output pins (D0 to D7) to the eight data latches in U3, which are updated by positive pulses from the HBEN line applied to the chip's CP (clock) input at pin 11. As a result, the 8K of EPROM data which is clocked out under the control of the A1 signal appears at the outputs of U3 (O0 to O7) when updated by HBEN, which acts in a synchronous manner with A1, as you would expect.

Finally, seven of these eight data outputs (O0 to O6) drive a simple digital to analog (D/A) converter based on the



Use this overlay diagram as a guide when assembling the MLS board — take care with orientation of any polarised components.

binary-weighted resistors R100 to R106, which is used to generate the MLS test signal at R110. Here, C107 acts as an output coupling capacitor while C108 is used to restrict the signal's harmonic content above the audio range.

The end result is effectively a bipolar (AC-coupled) signal with a bandwidth of about 20kHz, and an output swing of around +/-1V. The remaining data bit at O7 of U3 is passed back to the IMP board as control signal T, and is coded to indicate when the stored EPROM waveform is being clocked out.

Other than that, the remaining parts of the circuit include decoupling resistor R109, supply bypass capacitors C101, C102, C105 and C106, the 220k terminating resistor networks RN1 and RN2, plus filter components R107 and C103 which tame the action of the I/M* control line.

EPROM contents

It's worth noting at this point that since the EPROM's A14 address line (pin 27) is permanently held at a high level, the MLS option board is only using half of the possible address space of that 32K device — the upper 16K, as it happens. This in turn is divided into two 8K blocks by the action of the I/M* line, which operates under software control to select the MLS or standard impulse waveform as a test signal, since the latter is also 'recorded' into the EPROM.

This overall arrangement may well ring alarm bells in some reader's heads, for a couple of distinct reasons. We appear to be wasting half of the EPROM space, and the circuit uses a D/A converter to reproduce both the MLS and impulse signals, which are essentially digital signals in their own right — that is, all highs and lows...

As it turns out, the reason for this apparently inefficient approach is hidden in the EPROM itself, which also has two *sinewave* signals stored in the lower (unused) 16K of address space. With a 'low' tone in the first 8K block and a 'high' in the second, these signals are intended for future expansion of the IMP system, and would be accessed by connecting the (currently held high) A14 line to one of the IMP's PC-driven control lines.

So while the MLS board's simple 7-bit D/A is not really being used to produce analog signals during either the MLS and impulse tests, its full linear range would be called on when reproducing the stored sinewave test tones, should that option be implemented. In the meantime, we can just consider that the EPROM is larger than is required, and the D/A resistor ladder is only performing a minimal function.

That's about it for the circuit operation of the MLS board, and the principles involved. In spite of the complex nature of the MLS test signal and way it's resolved into an equivalent impulse response, the circuit board itself involves surprisingly few parts. As a result, putting it together should be quite a straightforward process.

PARTS LIST

Resistors

All 1% Metal Film:

R100	640k (see text)
R101A,101B,102	160k
R103A	68k
R103B	12k
R104A	39k
R104B,107	1k
R105	20k
R106	10k
R109	100 ohms
R110	2.2k
RN1,2	220k SIL resistor network

Semiconductors

U1	74HC4040 14-stage bin. counter
U2	27256 32k EPROM (see text)
U3	74HC374 octal D-type flipflop

Capacitors

C101	22uF 16V PC-mount electrolytic
C102,105	0.1uF MKT polyester
C103	1nF MKT polyester
C106,107	330uF 16V PC-mount electrolytic
C108	3.9nF MKT polyester

Miscellaneous

PCB coded 96mls8 (166 x 41mm), 28-pin IC socket, light-duty hookup wire, PCB pins.

Construction

All of the MLS option board's parts fit onto a relatively small single-sided PCB, which is coded 96mls8 and measures 166 x 41mm. This mounts on two pillars at the rear of the case, while all connections between the MLS and IMP boards are made with common light-duty hookup wire.

Commence the construction by checking for any shorts or broken tracks in the PCB pattern, then installing all of the lower profile components as shown in the MLS board component overlay diagram. Don't forget to fit the wire link which joins the +5V rail to pin 1 of U2, and check that the SIL resistor networks (RN1 and RN2) are installed with the correct orientation — the 'common' end has a square pad on the PCB pattern, and the resistor pack's internal connections can be confirmed with a multimeter.

Another point of consideration is resistor R100, which is shown as 640k. If you wish to be truly accurate with the binary weighting of the D/A resistor network, the 640k value will need to be made up from the series combination of 620k plus 20k, and this compound component then installed in the R100 position. However, since neither the MLS nor impulse test signals are really effected by the D/A ladder accuracy — as they are essentially digital waveshapes — R100's value is not overly critical.

So if you don't have the patience to make up the exact value for R100, just install a 620k or 680k resistor in that position. If the EPROM's optional sinewaves are then used by some future IMP enhancement, you can install the theoretically correct value of 640k so the D/A will accurately reproduce the stored 'analog' waveshapes.

The final, higher profile parts can then be installed as shown in the overlay diagram. Note that while we have used IC sockets in all three chip locations (U1, U2 and U3), the only one that's really needed is that for the 28-pin EPROM. In all cases though, take particular care with the orientation of all polarised components, including the ICs and electrolytic capacitors C106 and C107.

Once you are happy with the overall construction, fit the EPROM in its socket then attach moderate lengths of hookup wire to each of the IMP control line points on the MLS board, as marked on the overlay diagram. For neater final appearance, solder each of these to the correct PCB pad on the copper side of the MLS board — there should be a total of 10 wires.

With the MLS option board prepared for installation, the next step is to complete the alterations to the IMP PCB itself. As you can see from the reproduced IMP overlay diagram, there are 10 connections to be made for the MLS option, *plus* a copper track and resistor leg that must be cut.

Note that if your IMP unit has been constructed using a plated-through PCB from ME Technologies, these changes are much simpler. With the ME double-sided board, the track that must be cut has been replaced by a removable link and each MLS connection point has a matching PCB pin.

For other versions of the IMP PCB that do not have these added features, you will need to remove the board from its case and cut the bottom (non-compo-

nent) layer track as shown. Also, wire stalks or PCB pins will need to be added to the MLS connection points, before the board is reinstalled.

With both type of boards however, resistor R23 will need to be disconnected from the circuit so that the new MLS signal can pass to the test output socket, in place of the original pulse signal from IC7 (via R23). While the simplest method here is to just cut one of R23's legs, it could of course be completely removed. If you take the latter path though, note that if you don't have the appropriate equipment and expertise, you run the risk of damaging copper tracks while removing components from a double-sided PCB.

The final connections between the IMP and MLS board can now be made as indicated on the supplied IMP overlay diagram. Take particular care with the polarisation of pairs of connections such as those for the power supply (GND and +5V) and output signal (ANLG GND and TEST OUT). Once you are satisfied with these, fit threaded standoffs in place of the two rear IMP PCB mounting screws and screw the MLS board in place.

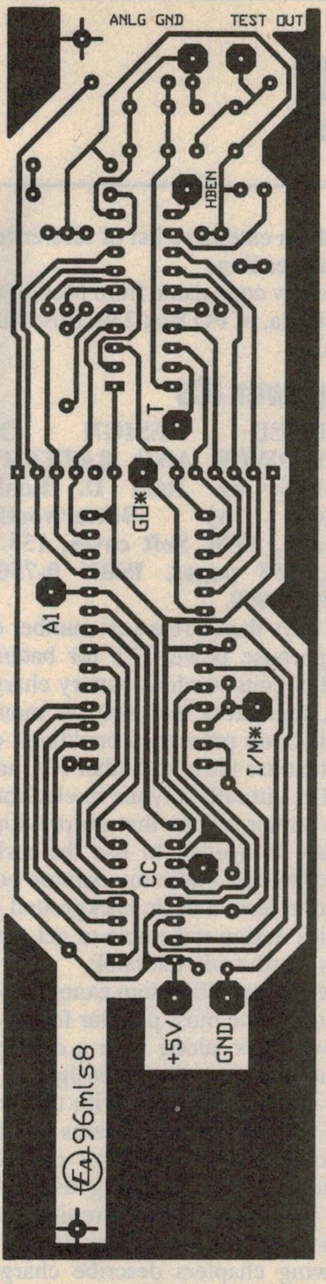
Testing & operation

You will need the more recent 'MLS-aware' version of the IMP software to use your new option board, as this offers the appropriate menu options and of course, the Fast Hadamard Transform capability. This can be checked by noting the actual name of the executable file, which should be **impm.exe**, rather than **imp.exe** — which is the earlier version.

If it turns out that you don't have the MLS-compatible program, the most recent version (2.0) of the IMP software is available from ME Technologies for $149, as detailed at the end of this article.

With that settled, power up the IMP module and run the software as normal. Then toggle the MLS option to 'on' (this can be found in the Acquire menu), connect the IMP module's test out socket to the probe 1 input with a suitable lead, and select Acquire, then Repeat. IMP will then read and display the 'raw' MLS signal without performing the Hadamard Transform, which allows you to look at the MLS signal in all its (somewhat random) glory.

If all looks well, you can start some serious MLS testing and begin to appreciate its benefits. Note that when you activate the more normal Acquire then Collect sequence of commands, the software will automatically perform the MLS-to-impulse conversion at the end of the collection period, so the return signal will only show as an impulse response.



A copy of the PCB artwork for the MLS board, shown at actual size.

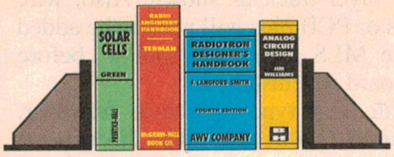
There's no doubt when the MLS testing method is operating during a speaker test however, since the relatively subtle 'snap' of the conventional test is replaced by an aggressive-sounding burst of digital noise. In line with this, you will also find that the testing level can be reduced to some extent, since the average energy contained in the MLS signal is many times that of the equivalent impulse test.

All in all, you should find that the MLS testing method offers considerable advantages over the impulse system, as we've found here at *EA*. While you really needed to perform several averaged tests for a clean result in the past, the MLS option delivers a faithful response in one quick burst.

At this stage, fully-built MLS option boards are available from ME Technologies for $237.90, and kits of parts should be available for somewhat less by the time you read this. We also believe that ME will be offering the programmed EPROM as a separate item, so you should be able to assemble your own MLS board from the information and artwork included in this article. It may also be worth checking with PCB manufacturers such as RCS Radio for the availability of the MLS circuit board itself.

Whichever path you choose to take, we would recommend that you contact ME Technologies for the current pricing and availability of all components of the IMP system. They can be contacted at PO Box 50, Dyers Crossing, NSW 2429; phone (065) 50 220 or fax (065) 50 2341. ME can also be contacted by email at me@midcoast.com.au or on the internet at http://www.midcoast.com.au/bus/me.❖

NEW BOOKS



Magnetic recording

MAGNETIC RECORDING TECHNOLOGY, by C. Denis Mee and Eric D. Daniel. Second edition, 1996, published by McGraw-Hill. Hard covers, 236 x 156mm, 678 pages. ISBN 0-07-041276-6. RRP $155.

This is the revised second edition of Part 1 of McGraw-Hill's *Magnetic Recording Handbook*, first published in 1990, which became widely used as a reference. The new edition is designed to provide an updated reference on virtually all aspects of magnetic recording technology — covering not just the developments that have taken place in conventional video and audio recording, but also those that have occurred in digital data recording.

There are 10 chapters in all, written by a total of 14 expert contributors including the two editors. An initial general introduction to magnetic recording leads to chapters covering the recording and reproducing processes, particulate media, film media, the micromagnetics of thin-film media, recording heads, the tribology of the head-medium interface, recording limitations, recording measurements and magneto-optical recording.

The emphasis throughout is on a clear description and sound understanding of the technology at a high level. This is not a book for the casual reader with an interest in the subject, but a thorough and detailed reference for the design engineer, researcher and post-graduate student. In that context, though, it should be of great value. Each chapter ends with an extensive list of references for further reading.

The review copy came from McGraw-Hill Australia, of PO Box 239, Roseville 2069. (J.R.)

Micropower ICs

SIMPLIFIED DESIGN OF MICROPOWER AND BATTERY CIRCUITS, by John D. Lenk. Published by Butterworth-Heinemann, 1996. Soft cover, 153 x 235mm, 255 pages. ISBN 0-7506 95102. RRP $60.

These days there are a vast number of special purpose power ICs for battery powered circuits, such as battery charging ICs, regulators and voltage monitors. This book presents a cookbook of circuits that use these and other ICs, and is aimed at virtually anyone in electronics. The author claims that no previous experience is needed to use the techniques explained, but in my opinion you will need at least a basic background in electronics design to be able to get your money's worth from the book.

He gives over 250 design examples of circuits using the most popular forms of micropower ICs, along with a description of basic battery-circuit design.

There are five chapters, with the first devoted to the basic problems in the design of micropower/battery circuits. The second covers selecting the right battery for micropower circuits, and includes a summary of battery types.

Following chapters describe charger circuits, solving problems involved with micropower circuits operating from a single cell battery, and then solving problems with circuits that operate from multicell batteries.

The ICs used in the application circuits are from a range of manufacturers, such as Maxim, National, Texas Instruments and Philips. Many of the circuits are from manufacturer's application notes and include step-up converters, laser diode drivers, temperature compensated crystal oscillators and battery charging circuits.

The review copy came from Butterworth-Heinemann, PO Box 146, Port Melbourne 3207. (P.P.)

SA's electronics industry

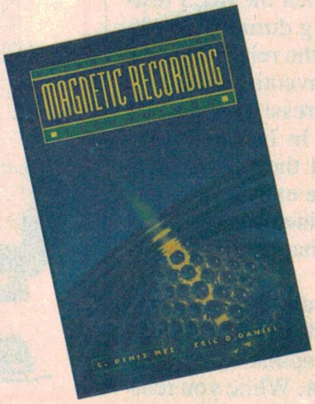
ADELAIDE'S EARLY RADIOS AND TAPE RECORDERS, by Neville Ellison. Published by the author, 1996. Soft covers, 300 x 210mm, 109 pages. ISBN 0-6462-7547-X. Price $19 plus $3.50 P&P.

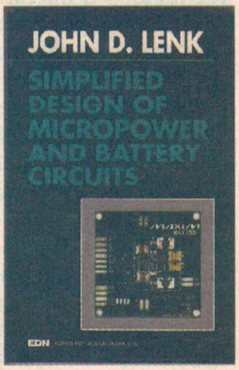
A book intended particularly for the vintage radio enthusiast, but also for those with a general interest in Australia's early radio and tape recording industry and technology. Author Neville Ellison is a keen historian and member of the Historical Radio Society of Australia, who worked in the South Australian industry — including a period with recording pioneer Jack Ferry. In the past Mr Ellison has contributed articles to *EA*, and nowadays he runs a museum of magnetic recording and playback equipment in Malvern, SA.

In this book he presents the results of careful research into the South Australian radio and tape recording industry. There are 15 chapters, which present the story of brands and firms such as Nomis (Lawrie Simon), Ferry, Operatic Radio (William Bland), Peerless and Claritons (A.W. Campbell Dobbie), RWC Vascoe and Standard (Reg George), Gladiola Radio (W. Black & Son), Savoy Radio (Steve Ray) and Scharnberg Strauss (Ernest & Oswald Smith).

There's not a huge amount of text in places, but plenty of interesting illustrations — many taken from magazines of the period concerned. Overall, the coverage is quite satisfying, and it should make a very useful reference both for vintage radio enthusiasts and students researching Australia's radio industry and its development.

It's available from the author at 67 Cremorne Street, Malvern 5061.(J.R.) ❖





Experimenting with Electronics

by DARREN YATES, B.Sc.

Still more 555 timer circuits...

This month, we finish off our look at the 555 timer (for the time being, at least) with some more circuits that use this incredibly flexible 'building block' IC in uncommon situations. There's even a sinewave oscillator to try out·

These days, you could argue that electronics has become little more complicated than playing with Lego. Everything comes in nicely pre-programmed packages, and all you have to do is slot the pieces in together to complete your solution. Some would even go as far as saying that you don't even need to know much about electronics any more, and that you only need to know the 'overall picture' to get a circuit going.

A large number of the digital protagonists would have you believe this, but in reality there is no substitute for a solid working knowledge of electronics down to at least the component level.

There is actually a parallel to this in the computing industry, and it goes a little like this: when a large corporation decides to create a software application, they don't get just one person on the job. In fact, it's not just left to one group but often several groups, whose task is to design the program layout and then divvy up the tasks to individual programming teams. You could say that this is similar to electronics at the building-block level.

Most program modules are characterised in similar ways to electronic circuits, that is, data comes in via an input, the module mucks about with it, and then spits it out via the output.

Few people these days care how it's done, so long as you get exactly what you want at the output. By making the code modular, any bug-fixes or changes can be quickly implemented without upsetting the rest of the program.

And this is where we come in. Many engineers will look for the easiest and quickest way to produce the end result. However, since most of us don't have big budgets, we need to be a little more clever in our design to achieve the same result with cheaper components.

Once you know circuits down to this level, it's not a big step to creating large projects using just these simple components.

The 555 timer is a perfect combination of a very practical and low cost module, and it can be made to do quite a number of differing jobs, as we've already seen.

So enough prelude, let's take a look at a few more 555 circuits.

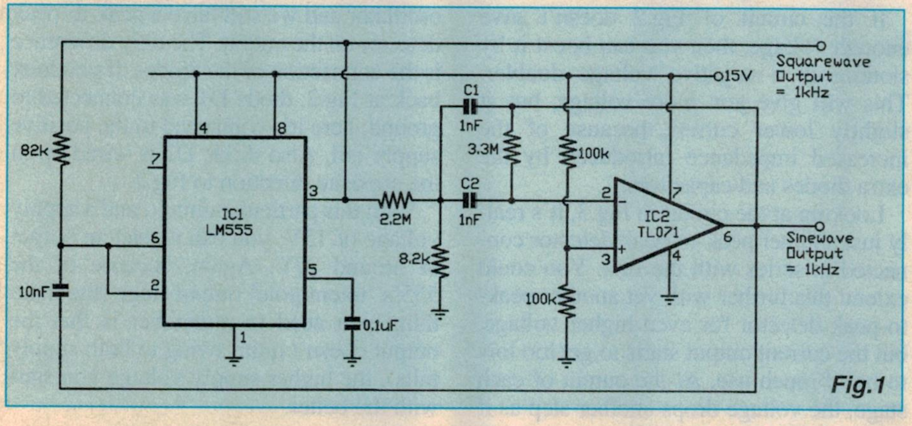


Fig.1

Sinewaves from a 555?

Well, with a little help, yes. This first circuit uses the 555 timer as an astable multivibrator at first, and then switches into a Schmitt trigger.

Looking at the circuit in Fig.1, the 555 timer is connected up as a very simple oscillator with the output at pin 3 coupled back to the trigger (pin 2) and threshold (pin 6) inputs.

The only difference comes in the negative side of the timing capacitor. Instead of going straight to ground, it's connected to the output of IC2, which is a TL071 FET input op-amp. This op-amp is connected as a bandpass filter, and it's the bandpass filter rather than the 555 timer components which really determine the overall frequency.

Let's take a run through the circuit's operation.

When power is first applied, the 555 starts up as an oscillator but the square wave signal from pin 3 is immediately fed straight into the bandpass filter. The bandpass filter in this circuit is set to 1kHz, which means that only this frequency passes through unimpeded. All others are reduced by increasing amounts.

This filtered output, which is now basically a sinewave with about 2% distortion, is coupled back to the 555 timer via what used to be the 10nF timing capacitor. Now once the circuit starts cranking up, the capacitor simply now acts as a coupling device and the 555 switches over to its Schmitt-trigger role, driven by the output from the bandpass filter.

As a result, you have two outputs: the square wave (almost) signal at pin 3 of the 555 timer and the sinewave output of IC2, both of which are in sync. At this supply rail voltage, the sinewave output is around 9V peak to peak, which is plenty of signal.

Varying the signal frequency requires changes primarily to the filter stage, with capacitors C1 and C2. Reduce their value to increase the frequency and vice versa. There are mathematical formulae for calculating the filter components out exactly, but we'll leave that for the future when we look at active filter circuits.

Voltage alchemy...

Ever need a quick way to create a negative supply voltage from a 12V battery? Well, Fig.2 is a simple and practical way to do the job. Known as a DC-DC converter, this circuit is not much more than a low-component count 555 oscillator feed-

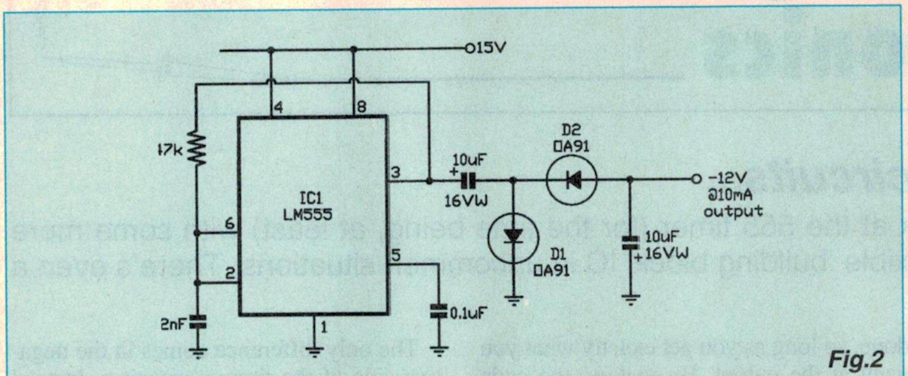


Fig.2

ing a peak-to-peak detector. It relies on the fact that capacitors can't change their voltage in an instant.

Capacitors are 'storers of energy', so if you charged a capacitor with a 5V supply and then quickly switched that supply to 0V (via some suitable impedance), the capacitor can't all of a sudden drop its bundle and go to 0V. Instead, what happens is that it forces the negative side of the capacitor down by the same margin. So if it was 0V, initially, then it drops down to -5V. Of course the capacitor discharges reasonably quickly and everything is soon back to square-one.

But if you could continually switch the capacitor on and off so that you could maintain the energy level in the capacitor, then you have a negative supply.

And that's what this circuit does.

As with most really simple circuits, there are a few limitations but so long as you know about them they shouldn't cause too many problems. Firstly, because the 555 doesn't have a symmetrical output stage, the output doesn't swing to both supply rails — which means that you should run this circuit on 12V or more, but no more than 18V.

Secondly, you should run the oscillator at as high a frequency as practical. This way you can keep the capacitor values and sizes small. The maximum practical current you can drag out of this negative supply is around 15-20mA — not enough for anything serious, but it will be enough for most op-amp circuits.

And finally, diodes with a low forward voltage drop like the germanium OA91 are better than silicon. 1N914s will do the job, but because of the 0.6V drop, you lose output voltage. There are a number of low-drop high speed diodes which are designed with this job in mind, and most of the garden-variety electronics stores carry one type of another.

Typically this circuit running from a 15V supply and with a 1kΩ load would give -12V or so.

If you need this rail regulated, use one of the low-current voltage regulators such as a 79L09 or less. But remember that these devices need a couple of volts of 'headroom'. There are other regulators with less demanding requirements, but they're a little more expensive.

More voltage, please!

If the circuit of Fig.2 doesn't give enough voltage, then you can boost it by slotting in a negative voltage doubler. This will give you more voltage, but at slightly lower current because of the increased impedance introduced by the extra diodes and capacitors.

Looking at the circuit in Fig.3, it's really just another peak-to-peak detector connected in series with the first. You could extend this further with yet another peak-to-peak detector for even higher voltage, but the current output starts to get too low to be of much use. At the output of each stage, the voltage drops another step as if you're going down a flight of stairs.

With this circuit, you can expect an output of -24V with a +15V supply rail. But you won't get much more than 10mA out of it before it begins to drop its bundle...

This type of circuit tend to be cheaper than inductor based DC-DC converters, but they don't provide anywhere near the amount of current. You can also build them much smaller as well, if that is an important factor to whatever you're building.

There's nothing magical about using the 555 timer here, except that it's ideal for the job because it provides the low-impedance switching output with enough drive to do the job with as few components as possible.

Positive voltage

Of course, you can also create a *positive voltage* output DC-DC converter as well. It's as simple as swapping a couple of components around. The circuit in Fig.4 shows how it's done.

The 555 timer is still connected up as an oscillator and we still have a peak-to-peak detector on the output. The only difference is the connection of the diodes. If you look back at Fig.2, diode D1 was connected to ground; here it's connected to the positive supply rail. Also diode D2 is wired up in the opposite direction to Fig.2.

With this particular circuit, and a supply voltage of 15V, you can expect an output of around 27V. Again, because of the 555's 'totem pole' output stage (the main thing you need to remember is that the output doesn't quite swing to both supply rails), the higher supply voltage you start with the better.

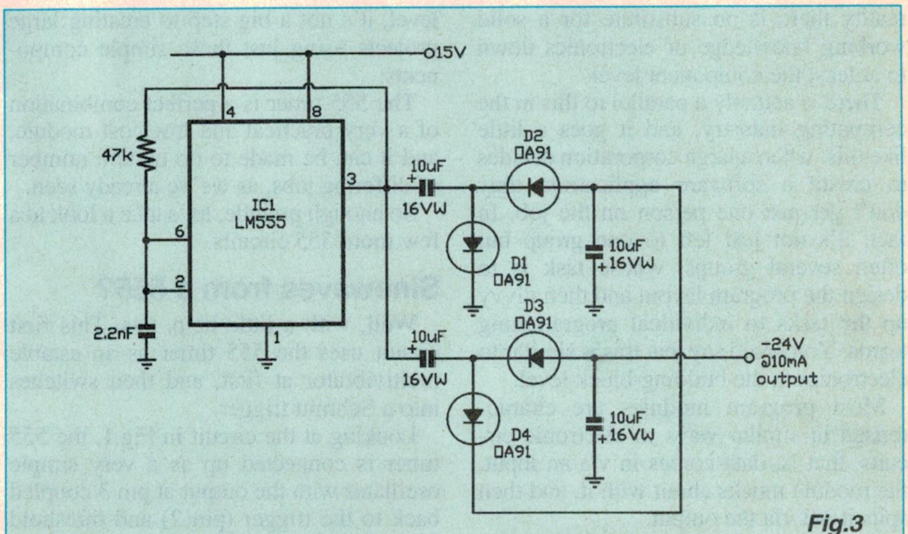


Fig.3

You can expect to get between 10 and 20mA out of this style of circuit fairly comfortably. It relies on the same principle as before, that a capacitor cannot lose or change its charge rapidly. The only real difference here is that we're charging up the capacitor to a certain voltage, and then shifting the ground of that capacitor up by 15V or so. The capacitor obliges by pushing its voltage upwards of 27V. It has a charge inside and there's nowhere else for it to go but up!

If the output at pin 3 is low, capacitor C1 charges up from the supply rail through D1. But when the output switches high, the capacitor's negative pin rises from 0V to 13V. The positive pin of that cap has to rise by that same amount, and so it rises to around 27V. Diode D1 prevents this charge dissipating back into the battery. At 27V, D1 is reverse biased and stops this from occurring.

On the other hand diode D2 is forward biased and allows the capacitor to dump its charge into the reservoir capacitor C2. This capacitor provides the 'grunt' for whatever circuit you connect up to it.

Once the output at pin 3 drops low again, the positive side of C1 drops back down to around 14V. If C2 is still charged up, diode D2 is reversed biased, and so stops any flow of current back into the circuit.

Again, you can either use higher value capacitors and a low frequency or you can use a higher frequency and smaller caps. This is the better option, since you can squeeze the size of the circuit right down.

Just as with the negative version, you can continue to build up the voltage by putting in more series rectifiers. You also get the reduction in current, of course, but if you only have modest current demands this may be the lowest-cost solution.

In the future, we'll be looking at better alternatives to doing this, and looking at a low-cost IC which allows you to produce just about any voltage you want from +80V to -80V DC.

555-based LC oscillator

One of the more unusual circuits I've seen is this LC oscillator which uses the CMOS version of the 555 timer. When the original 555 timer arrived on the scene, it was designed with TTL, but as you'll discover, if you haven't already, the 555 isn't all that cheap to run, particularly from batteries. It's a bit thirsty, consuming around 7-10mA on its own.

The CMOS version uses the same technology as your common CMOS logic ICs like the 4000-series logic chips. Low power consumption, output that swings to both rails and very high-impedance inputs, make the 7555 or LMC555 IC a very attractive solution to problems that the original circuit couldn't solve.

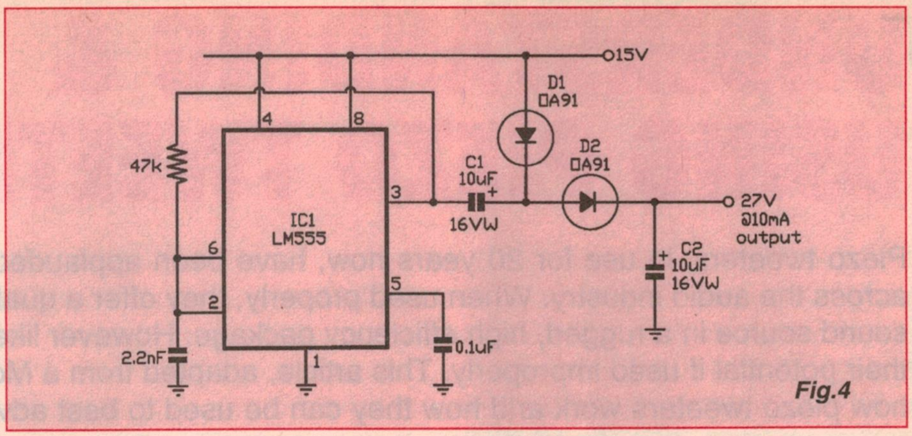


Fig.4

Fig.5 shows the circuit with a very common 'pi' LC network. The circuit takes the inverted output at pin 7 and feeds it back through the network to the combined trigger and threshold inputs.

The frequency of this circuit is set solely by the capacitors and inductor and can be worked out by using the following equation:

$F = 1/(2\pi \times \sqrt{(LC)})$

where $\pi = 3.14159$, L is the value of the inductor in henries and C is the value of the capacitors in farads (both capacitors should ideally be the same value).

This circuit has the benefit that its frequency is largely unaffected by heavy loads on the output — which isn't the case with most pi-network LC oscillators. The values shown produce a frequency of 10kHz, although you should be able to hit at least 50kHz quite easily with the 7555. As all ICs are different, you maybe able to push some 7555s to well past 100kHz; but don't rely on it across the board.

CMOS ICs such as the 7555 aren't usually noted for their speed, which is why you won't hit the high notes that other LC oscillators can handle. But it *will* produce more output current.

The most important thing about this circuit is that you need to keep the inductor value fairly high, otherwise the circuit falls back into the RC mode. If you look at it, if the inductor is shorted, you have the standard RC time constant that we're all familiar with. So you need to keep that inductor value up, to ensure that the circuit works as an LC type rather than an RC one.

Linear ramp circuit

You can also get the 555 timer to produce some quite linear ramp waveforms, which come with their own sync pulse. If you're playing around with any video signal circuits, this will be of some interest to you.

Normally, the timing circuit for the 555 as an oscillator simply consists of a resistor and a capacitor, which is fine for most things. But if you replace the resistor with a constant current source, then you can obtain quite a linear waveform by buffering the output across the capacitor.

The circuit for this is shown in Fig.6. As you can see, Ra, Q1 and the 10nF capacitor C1 set up part of the time constant here. The other part is set by the voltage level on pin 5. This provides the base drive and control for the constant current source.

Continued on page 101

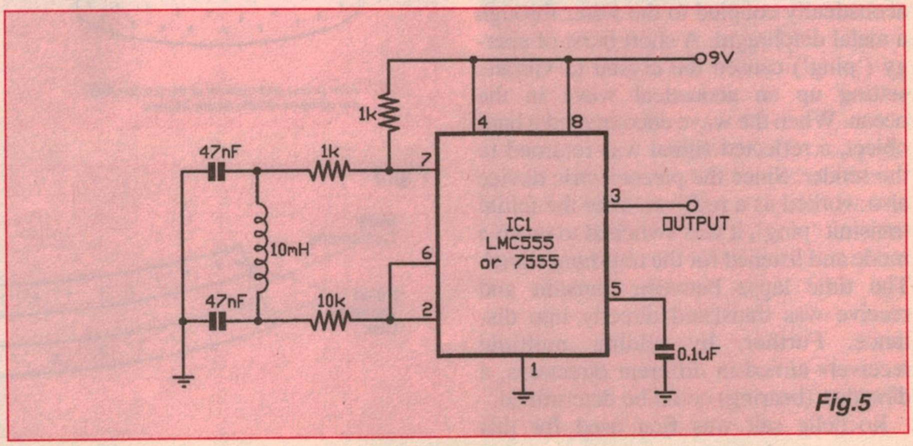


Fig.5

UNDERSTANDING & USING PIEZO TWEETERS

Piezo tweeters, in use for 20 years now, have been applauded and cursed to varying degrees across the audio industry. When used properly, they offer a quality cost-effective, high frequency sound source in a rugged, high efficiency package. However like many products they fail to meet their potential if used improperly. This article, adapted from a Motorola application note, explains how piezo tweeters work and how they can be used to best advantage.

Piezoelectricity was discovered in the late 1880s by Jacque and Pierre Curie, who found that certain natural crystals generate an electric field under the influence of a mechanical force. They named the phenomenon *piezoelectricity*, from the Greek meaning 'pressure' electricity.

Shortly thereafter, it was discovered that this phenomenon is a reversible one. That is, when an electric field is impressed across such a crystal, it undergoes a physical deformation. Since the actual displacements are very small (measured in millionths of an inch), the practical applications for piezoelectricity were slow in coming.

Various natural occurring materials were found to be piezoelectric, among them quartz, tourmaline, Rochelle salt, and even wood.

The advent of radio resulted in the need for a frequency-stable circuit component. Quartz crystals, vibrating at resonance, were found to operate consistently and are still the state of the art in frequency-stable components. This was the first high-volume major application of piezoelectricity.

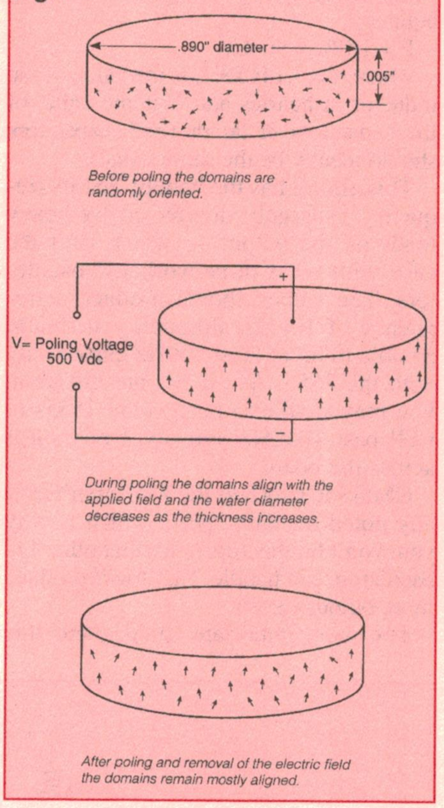
Underwater warfare in WWII generated a need for detection equipment analogous to the radar used for planes. It was known that acoustical signals travel extremely well in water, and the first acoustical application for piezoelectricity emerged. A piezoelectric crystal was acoustically coupled to the water through a metal diaphragm. A short burst of energy ('ping') caused the crystal to vibrate, setting up an acoustical wave in the ocean. When the wave encountered a hard object, a reflected signal was returned to the sender. Since the piezoelectric device also worked as a receiver, after the initial transmit 'ping', it was switched to receive mode and listened for the returning signal. The time lapse between transmit and receive was translated directly into distance. Further, by adding multiple receivers aimed in different directions, a direction (bearing) could be determined.

Rochelle salt was first used for this application because of its extremely high sensitivity. Unfortunately, it exhibited several temperature and moisture problems that made its use impractical.

A better material was needed. Independent research on both sides of the ocean resulted in a family of synthetic materials that offer high electro-mechanical conversion efficiency with greatly improved temperature and humidity stability characteristics.

This synthetic material is actually a ceramic, and is processed using methods similar to conventional ceramic sintering techniques. The material was called PZT, because it is a polycrystalline lat-

Fig.1

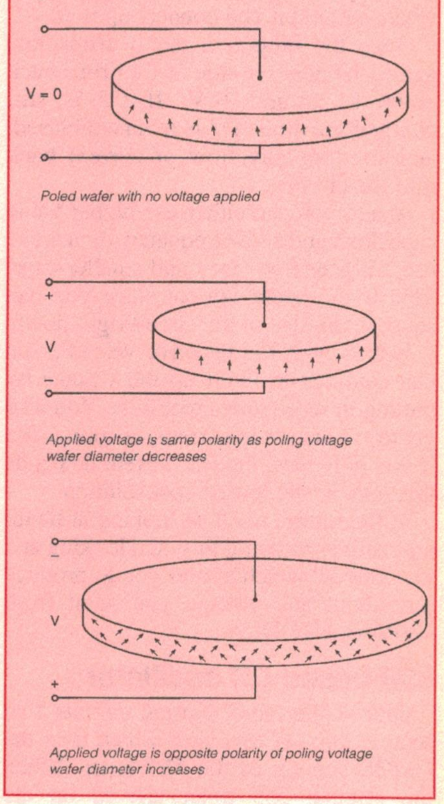


Before poling the domains are randomly oriented.

During poling the domains align with the applied field and the wafer diameter decreases as the thickness increases.

After poling and removal of the electric field the domains remain mostly aligned.

Fig.2



Poled wafer with no voltage applied

Applied voltage is same polarity as poling voltage wafer diameter decreases

Applied voltage is opposite polarity of poling voltage wafer diameter increases

Fig.3

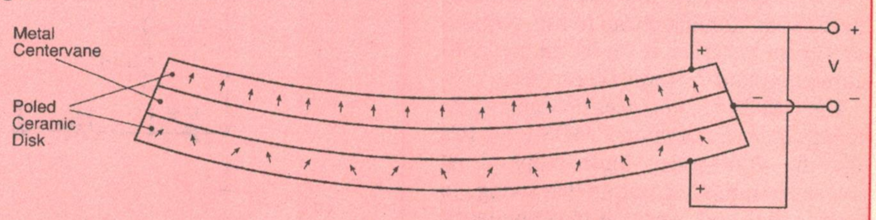
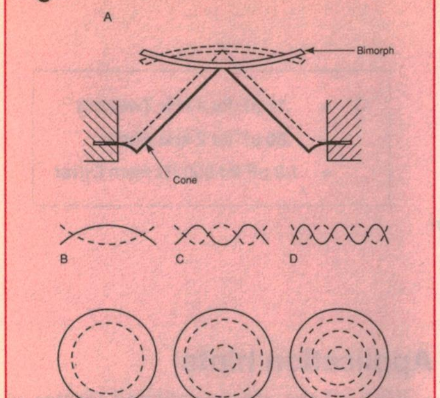


Fig.4



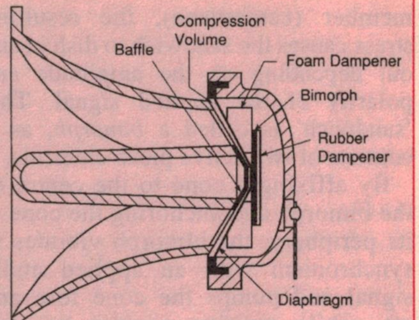
tice structure of the oxides of lead (P for Pb), zirconium (Z) and titanium (T). Since it can be formed using conventional ceramic processes, it offers more design latitude to the transducer engineer than do natural crystals.

A major difference between PZT and piezo materials found in nature (crystals) is that PZT must be processed further to make it piezoelectric. The microscopic crystallites, known as *domains*, are in random orientation in the PZT and must be aligned if the material is to be useful. This is done in a process called 'poling'. A high potential DC electric field is momentarily imposed across the material, causing the domains to align themselves with the field. Upon removal of the field, the domains remain aligned (see Fig.1).

The poled PZT is now truly piezoelectric and will stay that way unless an excessively high voltage is imposed upon it, or unless it is heated to a very high temperature (Curie point). If either of these conditions is reached, the energy input to the domains exceeds the internal binding force holding the domains in alignment, and the material once again becomes unpoled. This entire process is very much like the magnetizing of a magnet except we deal with electric fields instead of magnetic fields.

It should be noted that the ability of the PZT to retain its polarity is a function of the quality of the material. There are available low quality materials which will de-pole under normal use, causing a speaker to gradually lose efficiency (sensitivity). Motorola manufactures only the highest grades of PZT.

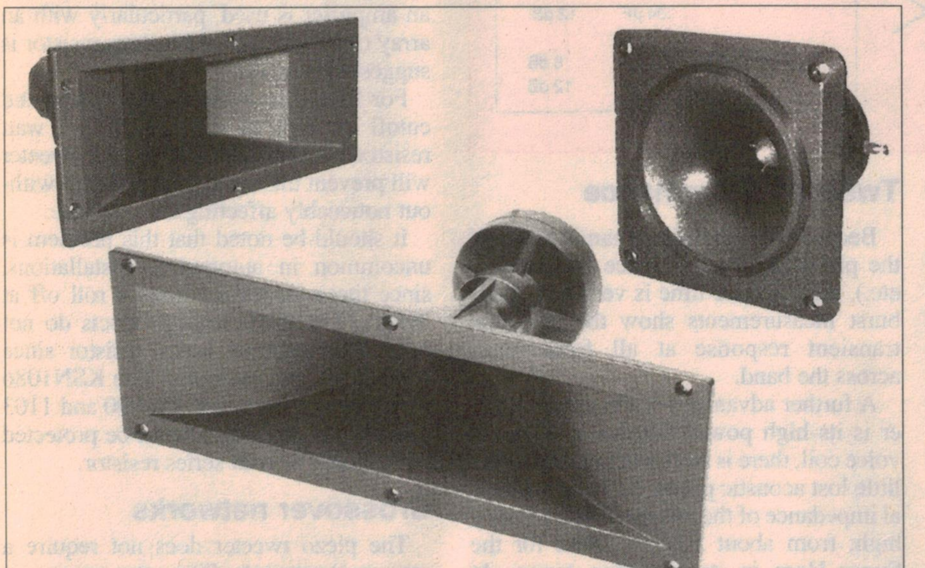
Fig.5



Theory of operation

In operation, the domains within a poled PZT wafer (Fig.2) alter their position slightly when an external field is applied. This causes a slight deformation in the physical geometry of the wafer. When the field is removed, the wafer returns to its original size. These displacements are very small (measured in millionths of an inch) but high in force, and when coupled directly to a liquid or a solid medium, are useful for generating discrete motions. When coupled to air, however, motions of these dimensions are useful only in the ultrasonic region where the acoustic impedance of the air is higher, and provides a better match to the PZT.

To provide useful motion in the audio region, a 'mechanical lever', or transformer, is required to convert the high-force, low displacement motion to low-force, high displacement. This is done by coupling two wafers face-to-face (Fig.3). The wafers are connected such that as one expands, the other contracts. When coupled at their faces with a metal



A selection of Motorola piezo tweeters

Fig.6

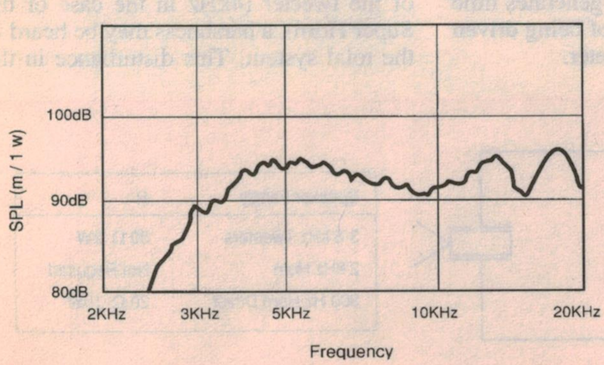
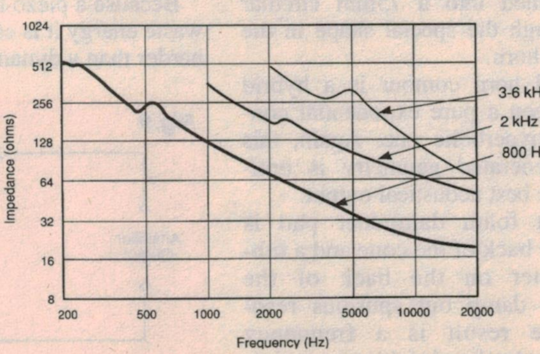


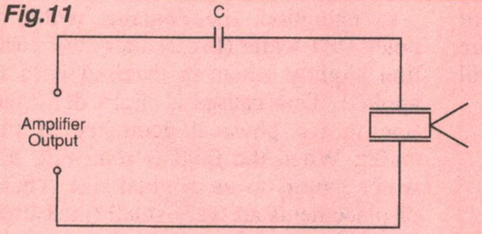
Fig.7



member (centervane), the resulting stress causes the sandwich to dish in and out depending on the amplitude and polarity of the applied signal. This 'sandwich' is called a *bimorph*, as it consists of two active piezo elements.

By affixing a cone to the centre of the bimorph and anchoring the cone at its periphery, the bimorph vibrates in synchronism with an applied audio signal and pumps the cone fore and aft, while pushing against its own mass (Fig.4). This concept, called the 'Momentum Drive Principle', was developed and patented by Motorola in 1970. It is the fundamental principle behind a broad family of speakers introduced in the ensuing 20 years, through many technical developments and dozens of patents.

Fig.11



	C	Attenuation
3 - 6 kHz Tweeters	.1 µF	6 db
	.04 µF	12 dB
2 kHz Horns	.3 µF	6 dB
	.12 µF	12 dB

Piezo tweeters

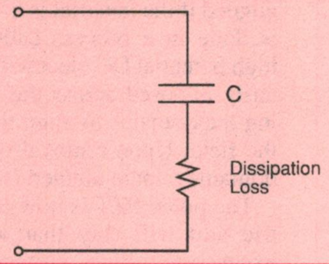
Let's consider, in detail, the construction of the Motorola Super Horn piezo tweeter (Fig.5). Although developed and patented in the early 1970s, it is still a workhorse in commercial sound installations.

The circular PZT bimorph in this case consists of two wafers, 22.6mm in diameter and 0.14mm thick. The ultra-thin wafer is required to achieve the desired acoustical performance. The bimorph is coupled at its centre to the apex of a specially impregnated diaphragm which then works into a compression volume. Slots in the compression space direct the sound into the throat of a horn. The radial slots are transformed into a 75mm circular mouth, through the special shape in the throat of the horn.

The actual horn contour is a hybrid design between a pure exponential contour and a hyperbolic one. Again, this computer generated geometry is optimised for the best acoustical output.

Finally, a foam dampener pad is placed in the back of the cone and a rubber dampener on the back of the bimorph, to damp out spurious resonances. The result is a frequency response (Fig.6) showing high sensitivity and smooth characteristics.

Fig.8



C	=	.12 µF for 4 kHz Tweeters
	=	.30 µF for 2 kHz Horns
	=	1.2 µF for 800 Hz Horn Driver

Again, it should be noted that low quality products are available on the market using poorly tooled parts and imprecise manufacturing methods. The results are inferior performance and unpredictable results. Motorola is proud of its commitment to quality and the consistently high performance of its piezoelectric speakers.

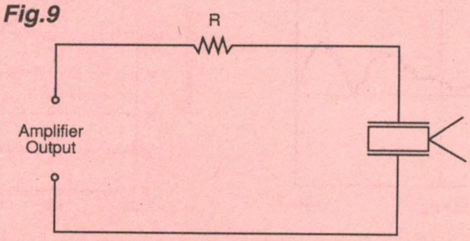
Tweeter performance

Because of the light dynamic mass of the piezo tweeter (no voice coil, spider, etc.), the response time is very fast. Tone burst measurements show the excellent transient response at all frequencies across the band.

A further advantage of the piezo tweeter is its high power efficiency. With no voice coil, there is no resistive heating and little lost acoustic power. In fact, the actual impedance of the tweeter (Fig.7) is very high, from about 50Ω to 250Ω for the Super Horn in its operating range. At these values, the amplifier sees little additional load from the tweeter, allowing use of arrays with little additional power load.

Because a piezo tweeter generates little waste energy it is capable of being driven harder than a dynamic tweeter.

Fig.9



Speaker Family	R
3-6 kHz Tweeters	50 Ω 2W
2 kHz Horn	Not Required
800 Hz Horn Driver	20 Ω 10W

Application hints

With all the aforementioned virtues of piezo tweeters, there are still some issues in their use with which the designer should be familiar.

A piezo tweeter appears like a lossy capacitor to the amplifier (Fig.8). As shown in the impedance plot (Fig.7), the impedance decreases with frequency. Many amplifiers today boast outputs that extend to 100kHz. At those frequencies, ultrasonic resonances may occur between the amplifier and the tweeter, causing damage to one or the other or both. If such an amplifier is used, particularly with an array of tweeters, a small series resistor is suggested (Fig.9).

For Motorola tweeters with a low-end cutoff of 3kHz to 6kHz, a 50Ω 2 watt resistor wired in series with each tweeter will prevent this resonance problem without noticeably affecting the response.

It should be noted that this problem is uncommon in automotive installations, since these amplifiers usually roll off at 20kHz. The 2kHz horn products do not require an external series resistor since one is built into each unit. The KSN1086 mid-range driver and KSN1090 and 1103 voice range products should be protected with a 20Ω 10 watt series resistor.

Crossover networks

The piezo tweeter does not require a crossover network. Since the tweeter is capacitive in nature, it rejects low-frequency power. However, if the mid-range or woofer is still operating at the turn-on of the tweeter (4kHz in the case of the Super Horn), a harshness may be heard in the total system. This disturbance in the

crossover region can be minimised by addition of an RC filter (Fig.10) tuned to attenuate the turn-on peak, or rolling off the mid-range a little earlier.

If a conventional crossover network is to be used, the tweeter must be made to look 'resistive' in order to work with the crossover. This can be done by wiring an 8Ω resistor across the piezo tweeter. It should be noted, however, that the power efficiency benefits now are lost since the piezo tweeter will look more like an 8Ω dynamic unit electrically. This will, however, allow the use of conventional crossover technology. If a variable level attenuation is desired, an L-Pad can be used.

If a straight level attenuation is desired, a simple (non-polar) capacitor (Fig.11) can be series wired.

Multiple tweeters

System sensitivity can be increased by adding piezo tweeters in parallel (Fig.12). The high electrical impedance of Motorola's piezo tweeters allows several units to be connected in parallel without overloading the amplifier.

Each time the number of tweeters connected in parallel is doubled, the average sensitivity for the array increases by 3 - 6dB. The actual increase depends on several factors such as off-axis angle, frequency, tweeter model and the configuration of the array.

For Motorola Super Horns, the on-axis response increases 6dB for each doubling. Part of this increase occurs because of the narrower beam produced by multiple horns. As the beam becomes narrower, the off-axis response degrades as a result of destructive interference between tweeters. The angle at which the destructive interference is the greatest depends on frequency and on the spacing between tweeters.

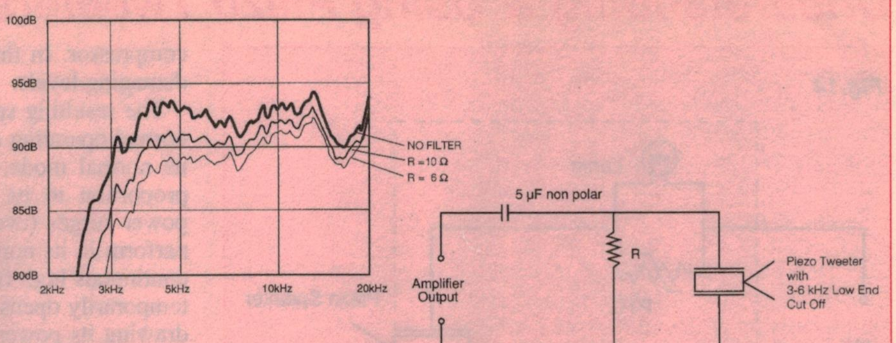


Fig.10

The destructive interference can be minimised in one plane by orienting a single row or column perpendicular to that plane. For example, if horizontal dispersion is more important than vertical, the tweeters should be mounted in a single vertical column. This assures that the horizontal dispersion of the array is identical to that of a single tweeter. The vertical dispersion, however, can begin to degrade significantly beyond 5°.

Mounting the tweeters at an angle (offaxis) with respect to one another can also improve the off-axis response.

Connecting piezoelectric tweeters in *series* doesn't increase system sensitivity, but it does produce higher sound pressure levels at maximum rated power (Fig.13). Maximum power handling capability of the array increases as tweeters are added in series. At maximum rated drive level, doubling the number of tweeters in series reduces the voltage across each tweeter by half, with a resulting SPL decrease of 6dB for each tweeter. The additional tweeters, however, create a 6dB increase for a net on-axis sensitivity change of 0dB.

If the voltage applied to the array is now doubled, so that each tweeter sees its maximum rated voltage, the array's on-axis SPL increases 6dB.

Fig.12

Number of tweeters connected in parallel	Average sensitivity change (dB)	On axis sensitivity change (dB)
1	0 (ref)	0 (ref)
2	+3	+6
3	+5	+10
4	+6	+12
8	+9	+18

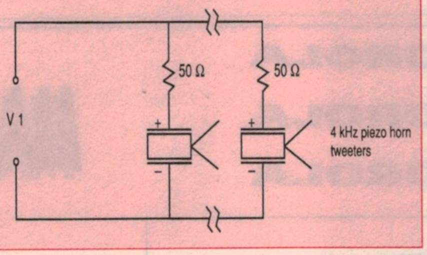
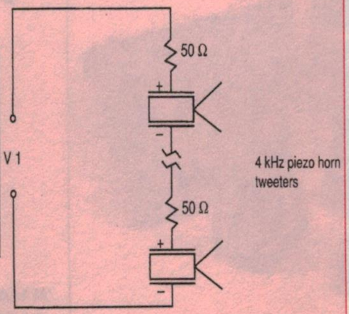


Fig.13

Number of tweeters connected in series	Average sensitivity change (dB)	On axis sensitivity change (dB)	On axis SPL at max. power rating (dB)	Max. array EIA voltage (V1 rms volts)	Max. array EIA power (watts ref. to 8 ohms)
1	0 (ref)	0 (ref)	0 (ref)	25	75
2	-3	0	+6	50	300
3	-5	0	+10	75	700
4	-6	0	+12	100	1250



Power handling

The power rating of Motorola's piezoelectric speakers is determined using the EIA RS426 test method. This is a continuous eight-hour noise test with peak voltage spikes twice (four times higher in terms of power) the average applied signal. Thus, for a speaker to be rated at 75 watts (25V), it must not degrade after eight hours of continuous operation at 75 watts with 300W spikes.

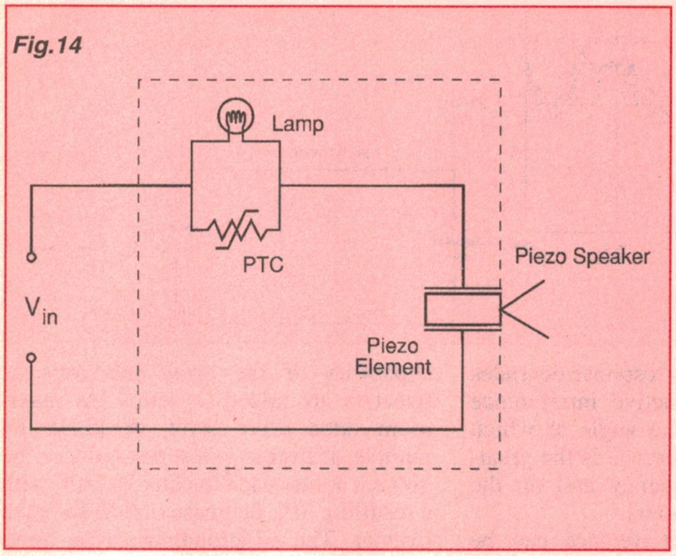
As a result of using the EIA test method, Motorola power ratings for its piezoelectric speakers tend to be conservative compared to conventional industry claims for speaker systems. In addition, the extremely dense, high-quality ceramic manufactured by Motorola withstands cracking and other high power failure mechanisms much better than the piezoelectric ceramic used by many other manufacturers.

Powerline Series

Motorola's Powerline series of 2kHz horns use an internal protection circuit which allows the horn to continuously handle the full output of a 400 watt (8Ω reference) amplifier. The protector is a parallel combination of a miniature light bulb and a positive temperature coefficient resistor (PTC) (Fig.14).

In a music system in which there is excessive clipping at high power, or high-amplitude high-frequency signal content, the piezo drive element sees very large currents and will heat up due to dissipa-

Fig.14



tion losses. When the PTC senses the high temperature it increases its resistance dramatically. This has the immediate effect of significantly lowering the power into the driver, and the SPL produced.

To avoid a sudden shift, and make the power control practically imperceptible, the miniature lamp is wired in parallel with the PTC. The lamp is essentially a very fast-acting PTC and responds to music peaks rather than RMS heating as does the PTC. The audible effect is similar to that produced by a level compressor. In this way, the driver temperature is held below damaging levels.

The resulting speaker performance then is as follows: under normal operating conditions, the powerline speaker performs in its normal mode, faithfuliy reproducing the signal applied in proportion to its volume. Under temporary, extremely high power surges (even in excess of 400W), the speaker will still perform in its normal expected mode. But now, if subjected to continuous high-frequency power, above 100W or so, the PTC temporarily opens up, allowing the speaker to continue to play, drawing its power through the light bulb, at a somewhat compressed power level.

The transition is smooth, and at the power levels being played at the time, barely perceptible to the human ear. When the speaker cools off. the PTC automatically resets, and conditions return to normal.

Conclusion

High quality piezoelectric tweeters such as those made by Motorola are capable of exceptional performance if used correctly and with a sound understanding of the way they operate. Small wonder that if you look behind the grille or fret of the speaker enclosures in many of today's professional sound systems, you'll find one or more Motorola piezo drivers.

In Australia, Motorola Piezo Tweeters are distributed by Freedman Electronics, of 283 Victoria Road (PO Box 3), Rydalmere 2116; phone (02) 638 6666 or fax (02) 638 7505. Many of the tweeter models are also stocked and readily available from firms such as Dick Smith Electronics, Jaycar Electronics and Altronics Distributors. ❖

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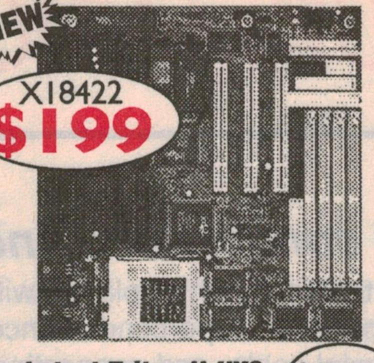

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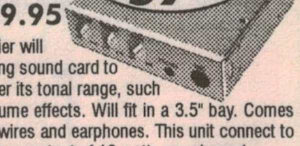

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INFORMATION CENTRE

by PETER PHILLIPS

Anti-gravity, battery connections and more

We have a rather scientific start to this month's column, with letters arguing against a May correspondent's suggestion of a link between superconductance and anti-gravity. There's also letters about the impedance of twin coaxial cable, and connecting batteries to give a range of voltages — and I have a go at Austel.

If you have an interest in electronics, it's likely you'll also be interested in a range of other scientific matters, such as cosmology, space research and so on. For this reason, we often include articles in the magazine about the latter, especially where electronics plays a part in the technology.

As well, I like to present letters in this column that raise scientific issues which while not purely electronic, are likely to be of interest to you. The most recent example is a letter from Wayne Shirley (Raby NSW), presented in the May 1996 issue, under the heading 'Superconductance and anti-gravity'.

As you might expect, a letter on such a topic is likely to draw a few responses, and I'm starting this month's column with some of these. Predictably, these letters disagree with the points made by Wayne, who argued there could be a relationship between superconductance and anti-gravity.

According to Wayne, superconductance can be represented as a third dimension on the usual two dimensional R-X phasor diagram. (See Fig.1.) The interaction between the resulting three dimensions could therefore give some interesting results, including implications for anti-gravity.

Whatever your views, one thing can be claimed: Wayne's letter has made readers think about the topic. And the more you think about such matters, the more you realise how little we really know. We still don't know for certain how the universe began, if anti-matter really exists, the composition of dark matter (which is supposed to make up most of the universe), and so on. Some of our most distinguished scientists and cosmologists (including Einstein) have held very different views on many of these topics.

The first two letters take Wayne to task in no uncertain terms, but I caution readers to consider the broader aspects. Firstly, the letters give opinions based on the writer's understanding. But who's to say anyone's understanding of such abstract topics is complete? Who understands gravity, and therefore anti-gravity?

But most importantly, whether you agree or disagree with them, the following letters contribute to a discussion that makes us all think a bit more about the world around us. Here's our first letter:

Phasor diagram and superconductance

I assume that Wayne Shirley's fairy story about superconductance and anti-gravity was written on the first of April. Or is it an example of 'science' fiction?

His attempt to develop a phasor diagram encompassing superconductance is indisputable as far as his first paragraph goes (to the coordinate origin). After that?

The limited current carrying capacity of superconductors is a non-linearity which the phasor diagram does not countenance, and can provide no bearing for the rest of his fanciful suppositions. Particularly as there is mathematical proof to show it's impossible to find another operator with properties analogous to $i = \sqrt{(-1)}$ that allows any three dimensional analogue of the Argand diagram; the basis of the phasor plot.

Except for stray capacitance/inductance effects which can equally distort the plot of even a simple resistor, superconductance is basically insensitive to frequency. Therefore any such graph (with its hopefully 'interesting results') would consist of only the origin, unless the resistance during overload is shown as another point on the +R axis. And the phasor diagram shows nothing about 'resultant fields and their interaction'. As for anti-gravity, it has about as much basis for inclusion as anti-smoking.

Apart from the inference that all negative resistance devices involve tunnelling (which is indubitably wrong in many cases, like a transistor pair with suitable positive feedback), there seems to be a fundamental misconception in his writing about negative or zero resistance. We live in a real world, to which various models have been applied so we can understand it better.

Except as a mental construct, there is no separate 'non-atomic (Newtonian) world', and any conclusions drawn from models (including a phasor diagram) are only valid to the extent to which their predictions can be verified. After all, that is the true purpose of any such model. That we may gain a better understanding of the way the real world operates is often a satisfying by-product, but its limitations have to be observed.

Otherwise it is easy to fall into traps as simple as: let $X = 1$; then $X-1 = (X+1)(X-1)$. Dividing both sides by $(X-1)$ gives $1 = X+1$, hence $1 = 2$. (Gordon Wormald, Florey, ACT)

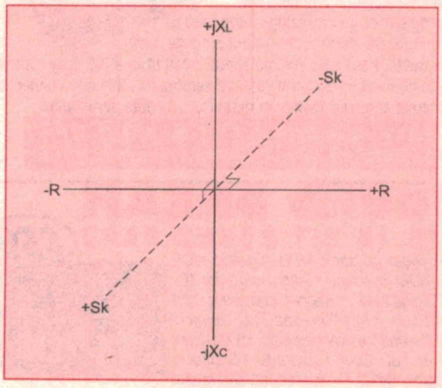


Fig.1: A 'three dimensional' phasor diagram, as proposed by Wayne Shirley.

You quite clearly disagree with Wayne's propositions Gordon, and I have to say I also find Wayne's views difficult to support. However, I am currently reading a book by George Smoot and Keay Davidson called *Wrinkles in Time, The Imprint of Creation*, that is challenging many of my fondly held beliefs about the universe. As well, this book proves to me how little we know about so many things.

Gravity is one of the least understood

forces in our universe, and Smoot has shown that the entire Galaxy is in fact travelling through space at around 600km per second, as well as expanding and rotating. Why? A suggestion is gravitational forces from a structure romantically called 'The Great Attractor'. He also discusses antimatter, which by definition includes antigravity. But relating this to superconductance is perhaps stretching things...

But what does our second contributor think?

Superconductance and anti-gravity

Superconductance and anti-gravity? Bats in the belfry more likely!

To begin with, a phasor diagram is not a definitive real-world description of impedance. Inductors are not in any sense at right-angles to resistors and the current does not travel in a different plane through a resistor than it does through an inductor. In short the phasor representation is a non-physical, convenient mathematical abstraction that is used simplybecause it works.

Superconductors have zero resistance that can be described as 0+j0 ohms. However it's not true that the current carrying capacity of a superconductor has any associated 'magnitude of superconductance'. The fact is all superconductors will stop superconducting when subjected to a magnetic field of the right intensity. The current generates a magnetic field which ultimately switches off the superconducting properties. The level of this field is not connected to some 'dimensional property', but simply to the material properties of the superconducting material itself.

In a quantum leap of credibility, your correspondent then goes on to draw some conclusions about anti-gravity. The speculated unification of gravity and the three other forces (electromagnetic, strong and weak), would occur only at the temperatures that might have existed in the first tiny fraction of a second after the big bang. How this could have anything to do with the properties of superconductors operating at near absolute zero temperatures is beyond me.

Your quest for an 'understanding' of quantum mechanics is doomed. Newton did not understand gravity when he proposed his famous laws. In fact he was distinctly uncomfortable with the concept of 'action at a distance' (action in Newton's day was the word for force, hence 'action and re-action are equal and opposite'). Today we understand gravity a little better, thanks to Einstein's general relativity, but we are still far from having a good handle on it. Much less so on anti-gravity, whatever it may be.

Most physicists studying quantum mechanics gave up long ago trying to understand it. Instead they have concentrated on uncovering the underlying principles, to the extent that workable mathematical models of particle behaviour can be developed. Like phasor diagrams, there is no necessity for the quantum mechanical models to have a real-world interpretation, other than the ability to correctly predict certain aspects of particle behaviour.

Roger Penrose of Oxford University, a leading worker in the quantum mechanical field, is living proof that crazy theories derived by misusing quantum mechanics are not entirely the domain of people who don't know the basics. He has a theory about human consciousness that goes something like this:

"Consciousness is weird and I, (Penrose) cannot see how it could have evolved from any ordinary biological means. Quantum mechanics is also weird and I do not understand it either, so there must be some connection between the two". He then rabbits on about the speculated habitat of the quantum mechanical engine in some obscure part of the brain that drives consciousness. He goes on to use the same argument to 'prove' that artificial intelligence will never produce consciousness. It's all very weird, really.

Although philosophical speculation on things quantum mechanical can be fun, I urge you to be careful with your sources, as disinformation and positively silly ideas abound. (Neil Boucher, Maleny, Qld)

I agree that 'it's all very weird', Neil. Which is what makes this topic so interesting. Yes, certainly there are many silly ideas around, but if you follow De Bono's method of problem solving, silly ideas can be very useful. Of course, that's not to say Wayne's ideas are silly, or that in the interests of discovery, we should devote the column to offbeat and silly ideas. But they do have a place.

For this reason, I don't agree with the way you dismiss Roger Penrose. In fact, I suggest you've somehow misrepresented him, as I doubt anyone would draw a connection between two concepts on the basis that they are weird. Lewis Carroll long ago showed that logical thinking of this sort can bring about very strange correlations.

Here's our final letter on this topic, which gives the title of a few reference books for us to examine for further information.

Further dimensions

Wayne Shirley may be interested to know that adding orthogonal dimensions is a trick that has been used by physicists for at least 100 years to unify magnetic, gravitational and other forces. There seems to be an agreement among theorists that 10 dimensions is required to adequately model all observed phenomena.

'Hyperspace' by Michio Kaku (Oxford University Press, 1995) provides a good easy introduction to unified field theory. 'The New Physics' (Cambridge UP) edited by Paul Davies provides a much more meatier treatment. It appears that superconductivity is no special problem for hyperspace modelling. (Rex Newsome, St Lucia, Qld)

Thank you, Rex for these references. If nothing else has come from this discussion, I would like to think our imagination has been fired, and your references give scope for further reading.

And now to more familiar territory...

Impedance of twin coax

In June 1995 I included a letter from a reader, David Allen (Findon, SA) seeking information about the characteristic impedance of twin coaxial cables when used as a balanced transmission line. I replied by saying it was a difficult problem, and that direct measurement is probably the only way to determine the impedance. However David has since sent me an answer to his question:

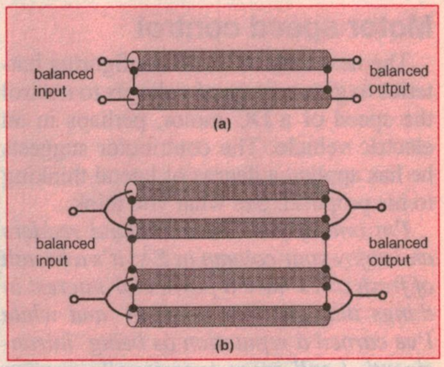


Fig.2: Shielded transmission lines made with coaxial cable have an impedance of twice the impedance of the cable.

I recently decided to update my 1974 ARRL Antenna Book, to the 1994 edition. On reading through it I discovered several paragraphs under the heading 'Shielded Parallel Lines'. As I thought it might be of interest, I have included a photocopy of the relevant section. It says:

'Shielded balanced lines have several advantages over open-wire lines. Since there is no noise pickup on long runs, they can be buried, routed through metal buildings or through metal piping. Shielded balanced lines having impedances of 140Ω or 100Ω can be constructed from two equal lengths of 70Ω or 50Ω cable

(RG-59 or RG-58 is satisfactory for amateur power levels).

Paralleled RG-63 (125Ω) cable would make a balanced transmission line more in accord with traditional 300Ω twin-lead feed line (Z0 = 250Ω).

The shields are connected together as in Fig.2(a), and the two inner conductors constitute the balanced line. At the input, the coaxial shields should be connected to chassis ground; at the output (the antenna side), they are joined, but left floating.

A high power, low-loss, low impedance 70Ω (or 50Ω) balanced line can be constructed from four coaxial cables, as in Fig.2(b). Again the shields are all connected together. The centre conductors of the two sets of coaxial cables that are connected in parallel provide the balanced feed.' (David Allen, Findon, SA)

Thank you David, for sending me this information. As I'm not an amateur radio or RF enthusiast, I don't keep up with the *ARRL Antenna Handbooks*, and therefore would not have found this entry.

Motor speed control

The next letter is about configuring batteries to give a range of voltages to control the speed of a DC motor, perhaps in an electric vehicle. The contributor suggests he has applied a degree of lateral thinking to his proposal. See what you think:

I'm one of your New Zealand readers and enjoy your column in EA; it's a breath of fresh air. I have a particular interest in things that are 'not possible' and while I've earned a reputation as being 'intransigent', I still enjoy occasionally proving the cynics wrong.

A recent article in EA described a very practical and serviceable chopper control for DC motors. While I acknowledge that resistive and chopper controls each have their merits, I like the idea of battery reconfiguration as a way of reducing losses and therefore heat in the control system.

As well as reducing heat loss, reconfiguring the batteries increases the availability of current for a series wound motor when starting and tends to protect the motor by not hitting it with full voltage before it has produced its back EMF.

However, so far everyone I've spoken to or read about has said it's simply not possible to reconfigure batteries to get any progression between half and full throttle. For instance, if you take four batteries, then in parallel you get one quarter voltage, paired you have half voltage and with all in series you have full voltage.

After trying this for different numbers of batteries, the conclusion is reached that no progression is possible between half and full voltage for any number of batteries, if you want to load all batteries equally, and keep them all in circuit. However, it is possible to do this. Let's assume a 36V series wound DC motor, and a 48V battery pack to allow for a voltage drop of 12V at full throttle. We'll use 12 batteries rated at 12V each.

For one quarter throttle, the batteries are all connected in parallel, giving a voltage of 12V. For half throttle, the batteries can be connected into two groups with each group comprising six batteries connected in parallel. The two groups are then connected in series to give 24V.

For three quarters throttle, the batteries are configured into three groups, with four parallel connected batteries per group. The three groups are then connected in series to give 36V. For full throttle, there are four groups in series, with each group comprising three batteries connected in parallel. This gives an output of 48V. Notice that for each throttle position, all the batteries remain in circuit, and are all equally loaded.

The same process can be used for other numbers of batteries. For example, with six batteries (of whatever voltage), we could reconfigure the batteries to get one third, two thirds and full voltage, or we might use 24 or more batteries, and so on.

The lateral thinking component is not assuming that all the batteries need to be in series to obtain full throttle. It seems simple enough to me, and perhaps it is common knowledge, despite claims to the contrary. (Stephen Butcher, Masterton NZ)

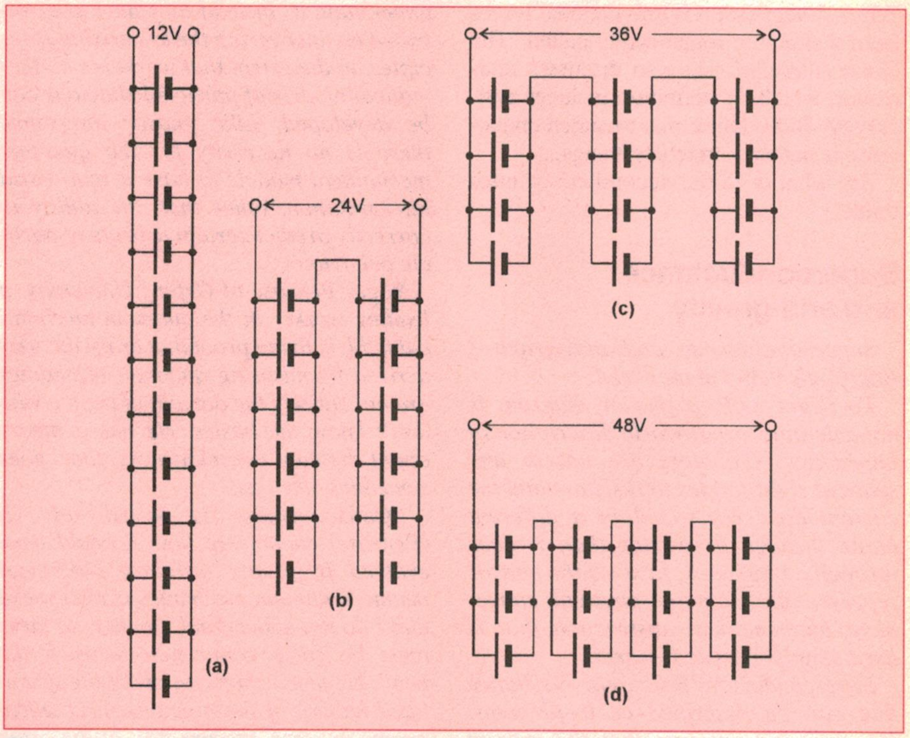


Fig.3: 12 x 12V batteries configured to give 12V, 24V, 36V and 48V, while keeping all batteries equally loaded.

Thank you for your kind comments and for this interesting way of interconnecting batteries, Stephen. Changing the supply voltage to a regulator to keep heat loss to a minimum is commonly done in regulated power supplies, and I assume in other applications.

Interconnecting batteries to give equal loading and a range of voltages is something that on the surface appears quite simple. But when you think about it, most of us would start with the number of series connected batteries needed to give full voltage, and arrange them accordingly for other voltages. As Stephen points out, this doesn't give enough voltage values, if equal loading is to be preserved. The battery circuits Stephen describes are in Fig.3.

Perhaps the only problem is the number of batteries needed, although the larger number would allow smaller batteries to be used. The switching needed might be rather complex, too.

TV as a computer monitor

The next letter seeks advice on two topics, starting with whether it's possible to use a conventional TV set as a computer monitor. The writer also makes a few points about computer systems in general.

I've never owned one, but I have always wanted to buy a computer system. I've been put off by the quick obsolescence, due to the constant improvements being made to computers, like faster Pentiums, MPEG video with surround sound capabilities, 1200dpi printers and so on.

However it seems to me that about one third the cost of a computer system is tied up in the monitor. Many people (like me) must already have a flat screen analog PAL TV set, and I'm wondering if it's possible to buy a device that will allow such a TV set to be driven from the A/V outputs of a computer. (John Barker, Warana, Qld)

There certainly is John, although I can't give you details on costs and availability. Their main use is to allow a large screen TV set to be used for presentations. I'm sure a reasonably qualified computer salesperson could give you the details you seek.

However let me make a few points against this. You mention obsolescence as a reason for staying away from buying a computer. While a computer is obsolete almost as soon as you take it out of the box, this is not the case for the monitor. I have updated my computer system three times over recent years, but I still have the same computer monitor.

As well, a conventional TV set doesn't have the bandwidth of even the cheapest computer monitor, and I'm sure you'll find working with it frustrating and hard on the eyes. A typical price for a 14" monitor is around $300 and I recommend you spend your money on this, rather than on an interface to a TV set.

Quite a few people use obsolescence as an excuse to stay away from computers, but ask yourself why you need the latest and greatest system. I recently enquired about a 75MHz Pentium computer system with all the essential bells and whistles, costing around $1500 (including monitor). Unless you do a lot of demanding graphics-based work, you'll find a '486 or low cost Pentium system perfectly suitable for most tasks. In other words, don't be fooled by the advertising that suggests you need to keep up with technology.

For instance, in 1984 I developed a computer system to interface with a reproducing piano (a type of vacuum powered player piano). This was based on an Apple II plus, the technology of the day. I sold a number of these systems, and all are still operating. Using today's technology would only bring about more convenience and a prettier screen display. For this reason I haven't bothered to update it. That is, you only update if you need to, not because it's the fashion.

Now to the second part of John's letter, which is about Austel and the now forbidden phone projects.

Phone projects

Some years ago I built a speaker phone project published in an electronics magazine, and have used it ever since. I'm sure there are many similar projects still connected to the phone system, all working perfectly and quite safe. While it may be illegal to have such devices connected to the phone system, it is surely not illegal for EA to publish articles describing them.

As well, in the past EA has presented articles about how phone equipment works, such as tone/pulse dialling and so on. From these articles, I'm sure many people could have built their own equipment, in which the constructor has the responsibility to get approval. Surely you can legally publish an educational type article describing how a particular device works. For instance, I would like you to describe a project to display the phone number of an incoming call.

If the big brother trend keeps going, it's likely it will soon be illegal to connect hobbyist projects to the power mains!

We've discussed the effect of Austel regulations before in the magazine, so I won't repeat the discussion except to say I tend to agree with you. But then, at the moment Austel is not my favourite organisation.

I recently purchased a fairly expensive Toshiba laptop computer, to be told that I could not use the inbuilt fax/modem/answering machine, as Austel has not yet got around to approving it. As far as I know, Australia is the only country where this device cannot be used. And to make it impossible for me to use it anyway, Austel has required Toshiba to leave out a vital part.

I presume Austel will eventually get around to approving it, when it suits them. I doubt if the safety requirements of the Australian telecom network are really all that different to those of other countries, and I can be pretty sure Toshiba would be unlikely to produce a device likely to endanger our network. After all, the computer and its fax modem work on three volts!

Returning to your comments John, I'm sure there's no law against us describing phone projects, but in these days of litigation, it's just not worth it. Sorry!

What??

This month's question is another from Peter Stuart. (Remember the timer question in June?) He asks:

Three electronics technicians held a series of kit building races amongst themselves. They decided to award a positive whole number of points for finishing first, second and third, where the number of points for finishing first was greater than the number of points for second, which was more than the number for finishing third. The same number of points was awarded for the same place in each race. There were no ties.

Altogether Sam accumulated 20 points, Michael 10 points and Colin 9 points. If Sam didn't win the preamp assembly race, who did?

Answer to August's What

A total of one trip up the stairs, and one trip back down again.

In the basement, the electrician shorted five pairs of wires, leaving one free wire. Then up to the fifth floor to identify the ends of the shorted pairs with the continuity tester, labelling each wire in each pair as A1, A2, B1, B2 and so on, with the last wire labelled F. These wires were then connected so A2 was shorted to B1, B2 to C1 and so on, leaving A1 unconnected.

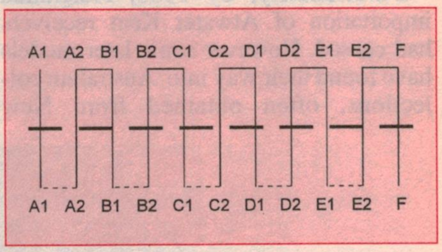


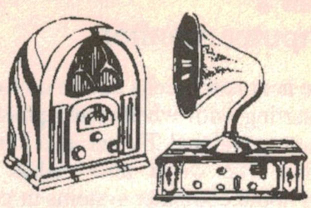
Fig.4: Showing the solution to the August What?? question.

Back in the basement, the electrician removed all the short circuits, but left the wires twisted at insulated portions so the pairs were still identifiable. He/she then checked for continuity between the free wire (known to be the lower end of F), and some other wire, which when found, must be wire E2. Its mate E1 could then be found.

The next test was for continuity between El and another end which, when found, could be marked D2 and its mate D1. Continuing in this fashion, the remaining ends were easily identified. This method obviously works for any odd number of wires. Fig.4 might help to explain. ❖

Vintage Radio

by PETER LANKSHEAR



Two different centennials, one for Atwater Kent

Be it a cricket score, an anniversary or a birthday, a century calls for special recognition. We have our own century this month, for this is the Vintage Radio column's one hundredth appearance. Our topic is also appropriate: the 100th anniversary of the founding of Atwater Kent.

In casting around for an appropriate topic for this, my 100th column, I discovered that this year there has been a centenary which although little publicised, has considerable significance for radio historians. It was in 1896 that American college dropout Arthur Kent started working full time in a modest manufacturing business that he had started between classes the previous year.

When he retired 40 years later Arthur was a multimillionaire, and his radio receivers, made over a period of some 13 years, many of them in what was at the time the world's largest radio factory, carried one of the best known and respected brand names. As my own vintage radio collection is centred around some two dozen of his receivers, I have a special interest and pleasure in devoting this column to the man and his products.

Unfortunately, by 1931, Australian importation of Atwater Kent receivers had ceased. However some later models have found their way into Australian collections, often obtained from New Zealand — which did import a good range from 1926 to 1936. New Zealand vintage radio enthusiasts have indeed been fortunate in having access to a good representation of these fine receivers.

Arthur Kent was born on December 3rd 1873 in Burlington, Vermont to Prentice J. and Mary E. (nee Atwater) Kent. Prentice's occupation was that of a machinist, and no doubt this was an important factor in young Arthur's formative years. Even today, Burlington has little industry.

In 1881 the family moved to Worcester, Massachusetts for what we can assume were better prospects. 1895 saw Arthur, then 22, enrolling in the Worcester Polytechnic Institute. Apart from excelling at mechanics and drawing, his academic achievements were somewhat abysmal — largely, it would seem, due to his preoccupation with the Kent Electric Manufacturing Company, maker of small motors and generators, a modest sideline that he had established the back of his father's shop. The following year Arthur abandoned all pretence at studies and concentrated on full time business activities.

It was in 1902 in Philadelphia, Pennsylvania, that he founded his second company: the Atwater Kent Manufacturing Works, making batteries, testers and domestic telephones. It would seem that with his good marketing sense he reasoned that adding his mother's name gave distinction to the firm's title. Business must have been good, for in 1905 he purchased his first motor car.

Improved ignition

Problems with Arthur Kent's car led him into his first major achievement, the single spark coil ignition system. Early petrol engine ignition was by either magneto or trembler coil. Arthur found that with increasing engine speeds, the trembler coil system was inefficient in that only the first of each train of sparks did any work and its timing was imprecise.

The single spark of the magneto was much superior, so he designed a new coil system, which he called the Unisparker. This was in effect a stationary magneto with an internal electromagnet. The Unisparker kit incorporated contact breaker points and condenser, coil, a centrifugal advance mechanism and a distributor.

If this sounds familiar, it should, for it is the standard 'Kettering' automotive ignition system that only in recent years has been displaced by electronic ignition. Just how Boss Kettering of General Motors came to have his name attached the Kent invention has not been explained, and presumably there was some form of licensing agreement with Kent. For this achievement, in 1914 Arthur Kent was awarded the John Scott Legacy Medal and Premium by the Franklin Institute.

Unisparker components, along with Atwater Kent self starters and car lighting systems, were sold through a national network of dealers and agents. Atwater

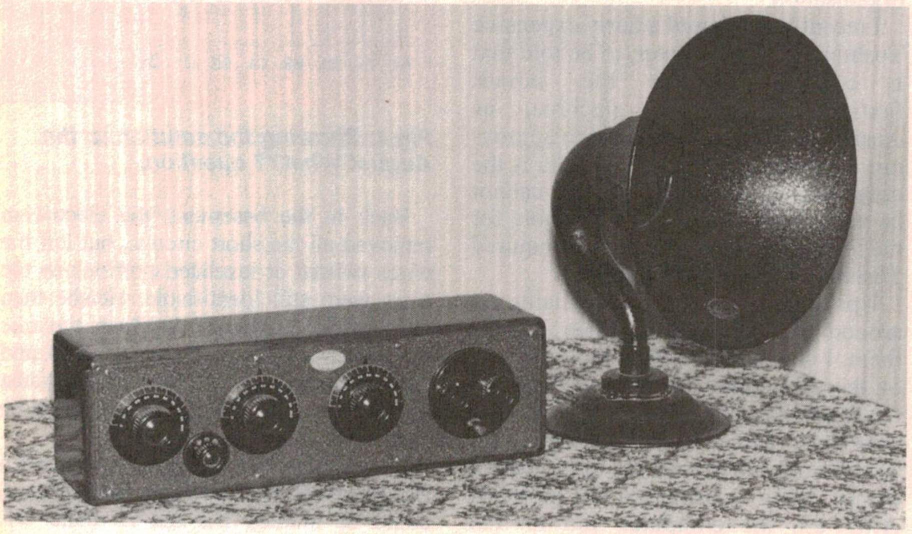


Fig.1: The attractive little 1926 model 20C was a hit with the ladies, and is the oldest A-K model commonly found in Australasia. Whereas contemporary loudspeakers commonly had aluminium or paper-mache flares, Atwater Kent made his of heavy gauge steel!

Kent Manufacturing grew into a thriving enterprise, and was granted World War I Government contracts for supplying precision gun sights and fuse setters.

Arthur Kent was one of those rare individuals who had more than his share of the gifts that make for a business genius. He was a friendly workaholic, a good employer and a perfectionist with an uncanny instinct for marketing and finance. In addition, he had an artistic eye and was a first rate inventive engineer. (He eventually took out a total of 93 patents). Put these all together, and you have the ingredients for an industrial giant.

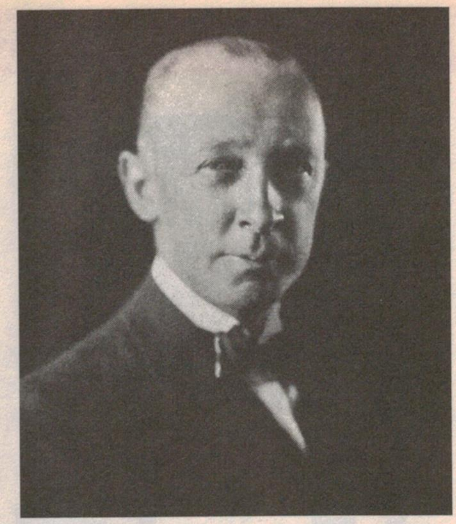
Phenolic moulding and deep drawing of steel pressings were in their infancy, and Kent became a master of these technologies. In 1928, he claimed to have the largest privately owned Bakelite moulding plant in the world. A comparison of an Atwater Kent moulding, such as a tuning knob, with one of its contemporaries reveals a clearly superior finish and finer detail.

Similarly, his metal fittings and pressings were well finished and accurate in size. To him appearance was most important and later, standard cadmium plating was not good enough for his radio chassis. His were heavily nickel plated, and the brass badges used on early receivers were gold plated. Restorers please note — NEVER use Brasso on A-K badges!

A new venture

By 1921, the Atwater Kent war contracts were finished, business was depressed and automobiles were now being factory fitted with single spark coil ignition, electric lighting and self starters. It was time to look around for new products to make...

By good fortune, the right opportunity presented itself and at the right time. A new craze, radio, was just taking off and Arthur Kent was on the spot to satisfy the demand for high quality components. The situation was ideal, for his plant was capable of turning out precision phenolic mouldings and metal parts, and had wire winding facilities. Furthermore, he already had a country wide distribution network.



A photo of Arthur Atwater Kent, from the frontispiece of the Company's 1928 catalog.

The Atwater Kent factory duly tooled up, and in mid 1922 was producing a series of well designed components including variometers, RF and audio transformers and two-stage audio amplifier modules. Not only did these work well, but they were superbly finished in attractive colour schemes. Experience gained in making reliable automotive electrical equipment must have paid off too, because I have never encountered an open circuited or green spotted Atwater Kent RF or IF coil winding.

With the success of the component line assured, the move to complete receivers was inevitable. At the beginning of 1923, sets of components were being assembled on mahogany 'breadboards'. These complete receivers too were a hit, and no wonder. With their polished wooden bases and gleaming components, the Atwater Kent receivers looked a picture. It is no surprise that today, Atwater Kent Breadboards are amongst the most sought-after collectables in the radio world, and can command astronomic prices.

During 1923 and 1924, a series of increasingly more elaborate Breadboards was produced, culminating in several versions of the model 10 — a five valve, three knob TRF.

Progressive design

One of the great attractions that Atwater Kent receivers have for me is the steady progression of design and components from one model to the next. Many manufacturers have discovered to their cost that revolutionary model changes can be disastrous. However, each new Atwater Kent receiver had proven features and components from its predecessors, yet was still at the forefront of technology.

Arthur Kent — by now calling himself Arthur Atwater Kent — had no hesitation in employing the best staff available. One notable member of the team from 1925 onwards was John Miller, discoverer of the Miller Effect whereby the characteristic of the grid input impedance of a valve is dependent on the stage gain and anode load.

Arthur did not think small. Even in 1924 he was spending $1 million annually on advertising, growing to something like $4 million in 1927. In 1924 he built a new $2 million facility, covering five acres. Eventually this was to grow to two plants covering 15 acres, at the time the world's biggest radio factory!

Attractive as the breadboards were to enthusiasts, Kent realised that they did not necessarily appeal to the ladies. In 1925 he put the model 10 into a cabinet. The model 20, as the new set was called, was typically innovative. Whereas the standard 1925 radio still looked very technical, frequently with black engraved panels, the Atwater Kent approach was to use a much cheaper but visually attractive grey/brown fine wrinkle finish on a steel panel, set off by a polished

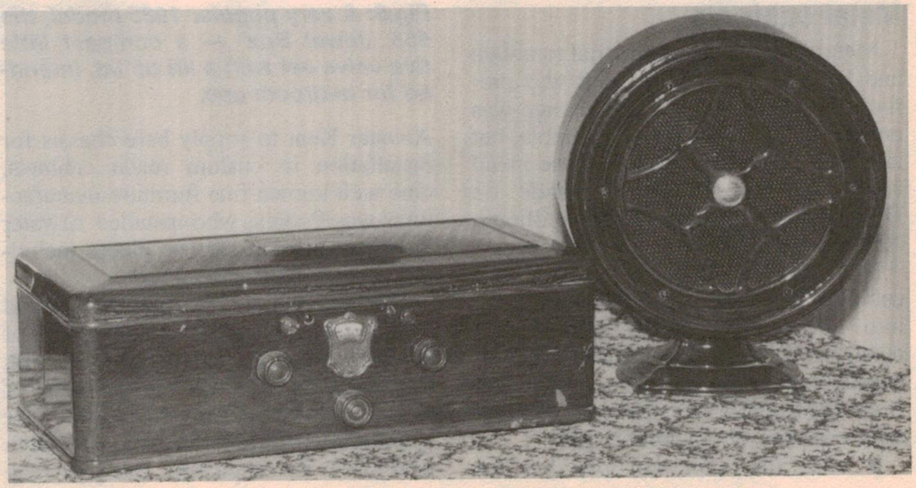


Fig.2: Atwater Kent convinced the public that radios should be in metal cabinets. This 1929 model 55 TRF with two RF stages used the new 224 screen grid and type 245 output triodes. The pressed steel casing houses a 12" moving coil speaker, and with typical A-K precision, more than a single coat of lacquer will prevent the two halves fitting together !

mahogany cabinet.

This proved to be a winning combination, but Arthur Kent had yet another trick with the 20, again calculated to gain the approval of the ladies. The contents were shoehorned into a cabinet only half the height of the model 20. Again the Kent instinct proved correct, and the little model 20C (C for compact) was another best seller.

The 20C has a special significance, for it introduced the Atwater Kent label to New Zealand — and it appears, Australia, where A.G. Healing were the distributors. The New Zealand distributors were the C.& A. Odlin Company, building supplies and hardware merchants whose first shipment arrived at the beginning of 1926. Odlins continued as the agents until Atwater Kent's closure 10 years later, and it is their active promotion that has left us today with the legacy of a good range of models.

Radio competition was keen, and the next move was to gang the tuning capacitors for single knob tuning. This was not easy, as with the tuning systems then in use, connection of an aerial upset the tracking of the input RF stage tuning.

John Miller came to the rescue and with the 1926 model 30, single control tuning was achieved by adding an extra valve as an untuned aerial isolating stage. The existing pattern of tuning capacitor was retained, but the units were ganged by means of phosphor bronze belts.

Several related models were produced during 1926. I have one, a model 32 with four belt coupled tuning capacitors, and a string of seven '01A valves! The cabinet is the same pattern as the model 20C, but nearly 60cm long! Metal framed tuning capacitors were adopted shortly after, but a more significant change came with the adoption of metal cabinets late in 1926.

Metal cabinets

Metal was a cheaper material to obtain and fabricate than wood, and was preferred by Arthur Kent. The change was an innovation, and a bit of a gamble, but as usual, it paid off. One of these metal cased sets, a model 35, made on December 3 1926, was the one millionth Atwater Kent receiver.

Not only did the public accept metal cabinets, but other manufacturers came into line and by 1929, quite a few receivers were being installed in 'tin trunks' as they are now known. Atwater Kent even turned out receivers in metal mini consoles, about table height!

It was also common practice for Atwater Kent to supply bare chassis for installation in custom made cabinets. One well known fine furniture manufacturer was Pooley, who installed Atwater Kent receivers in various pieces including writing desks and tables!

Fig.5: The eight-valve 708 of 1933 is a remarkable set for its size. A very early all wave receiver, coverage is continuous from 550kHz to 20MHz, with the RF stage used on all bands, and there are two 472.5kHz IF stages.

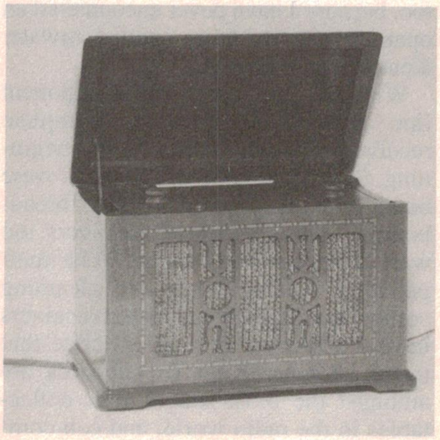


Fig.6: A very popular 1933 model, the 555 'Jewel Box' — a compact little five valve set with a lift up lid, intended for bedroom use.

The late 1920's were a period of rapid developments in radio technology, one of the most significant being in 1927 with the viable solution to the problem of mains powering of receivers. Our November 1995 column dealt in depth with these developments and you may recall that with the release of the model 36 in October 1927, Atwater Kent was only a month behind RCA in introducing their first AC set.

The 36 was actually a modified battery powered model 33 with a separate power pack. But on Christmas Eve 1927, Atwater Kent revealed their winner, the model 37. The 37 was a new design, although of course still all-triode and with a production rate of 3000 a day. By mid February 1928, 100,000 had already been made.

It is interesting to note that Atwater Kent never used neutralisation — not officially anyway. On paper, stabilisation of his receivers was by means of stopper resistors in the grid leads of the RF valves. But the reality was that there was some crafty orientation of the unshielded tuning coils, to provide hidden neutralisation.

Given the production rate of their receivers, Atwater Kent would have had to pay out enormous neutralisation royalties to the Hazeltine Corporation, and Arthur was too good a businessman not to try avoiding that possibility. Even the mighty RCA had to compromise over the question of patent royalties from Atwater Kent, who was too important to run the risk of losing a case against, and Arthur had very good patent attorneys.

However the Hazeltine Corporation finally did manage to obtain a judgement against Atwater Kent on February 19, 1934 for $680,000. This was several years after Atwater Kent had ceased using triode RF amplifiers anyway, and was probably only a fraction of the real royalties due.

Screen grid valves

The next year, 1929, saw significant new developments in the 224 mains powered screen valve and the 245 power output valve. Again Atwater Kent were to the forefront, and by late 1929 had a range of screen grid TRF receivers including the metal cased 55 and 60, with pushpull output stages and moving coil speakers. As usual, the bare chassis was available for the customer's own choice of cabinet.

During 1930 development of the TRF continued, and receivers were now available in Atwater Kent's own wooden cabinets. The best known here was the handsome model 70, available with a choice of four chassis for 60Hz, 25Hz and DC mains power, and also battery operation. There are pictures of this set and its chassis on page 12 of

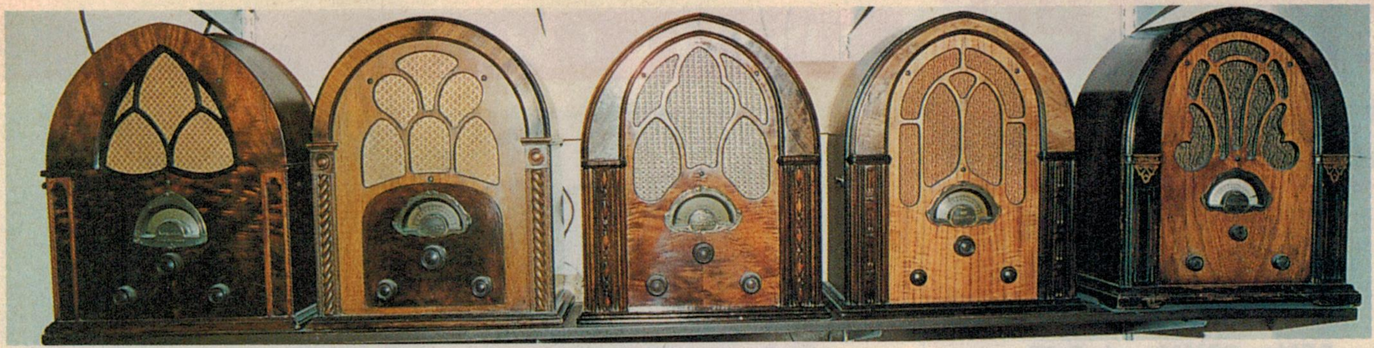


Fig.4: In production for only two years, the Atwater Kent cathedral receivers are very popular with the public and collectors. from the left are a model 84 'Golden Voice', a model 80, a 567, an NZVRS 'badge' model 627 and finally a battery powered 387.

Discovering Vintage Radio, volume 1.

At the end of 1930 came a most significant event in the history of radio production. RCA was obliged to give up its monopoly on the superheterodyne. Immediately the TRF was obsolete and, the American radio industry, already in bad shape because of the Depression, had to restructure with many firms going under.

Atwater Kent survived intact, but for much of 1931 there were no new models released. The L2 TRF chassis from the model 70 was modified as the model H superhet, but was at best a compromise and few were sold, although I do know of one in New Zealand.

By the end of 1931, a major part of the output comprised inexpensive superhets known variously as 'miniature', 'compact', 'gothic' and later 'depression' radios, the first being the model 84 Golden Voice. These sets, made for a period of only two to three years, are now much sought after not only by radio collectors but also the antique fraternity.

Atwater Kent managed always to produce distinctive and attractive cabinets, slightly ornate with some quite innovative designs such as the pair in Fig.5 and 6. As well, for the top ranking receivers, there were consoles with handsome cabinets, often with six legs. Unfortunately for Australasian collectors, Atwater Kent continued to export bare chassis for installation in locally made consoles which lacked the 'class' of the American product.

There were now three broad ranges of Atwater Kent receivers, all in continuing development. There were the prestige sets just referred to, with up to a dozen valves, and some with two speakers. Next were the mantels, first in cathedral cabinets, and after 1933, increasingly in flat topped 'modern' cabinets. Finally, there were the miniature sets, one of which the 555 'Jewel Box' in Fig.6 is today a great favourite.

Technical design of Atwater Kent equipment reached its zenith in 1934, and a good example of this is the model 447 whose chassis is shown in Fig.7. The same front end subchassis as used in the 447 was used in several of the top line models for 1934.

Metal valves

The next year, 1935, saw the introduction by RCA of metal valves. Atwater Kent was quick off the mark to use them, although in reality the conversion from the older valve series entailed little more than changing the valve sockets.

Things were changing, though. In 1936, Arthur Atwater Kent was now approaching his mid 60s and the radio market had changed. Technical design had matured and was now standardised. In fact, until the end of the valve era some 30 years later, there were to be few significant new developments. There weren't the challenges any more, and according to some accounts, labour unions were becoming stroppy. It was time to retire.

In an unusual move, he refused to sell his business, although some of his senior staff pleaded to purchase it from him — he didn't want there to be any chance that the good reputation of the Atwater Kent name would be compromised. Instead he paid off his staff, sold the plant and shut his factory doors. It is reported that some

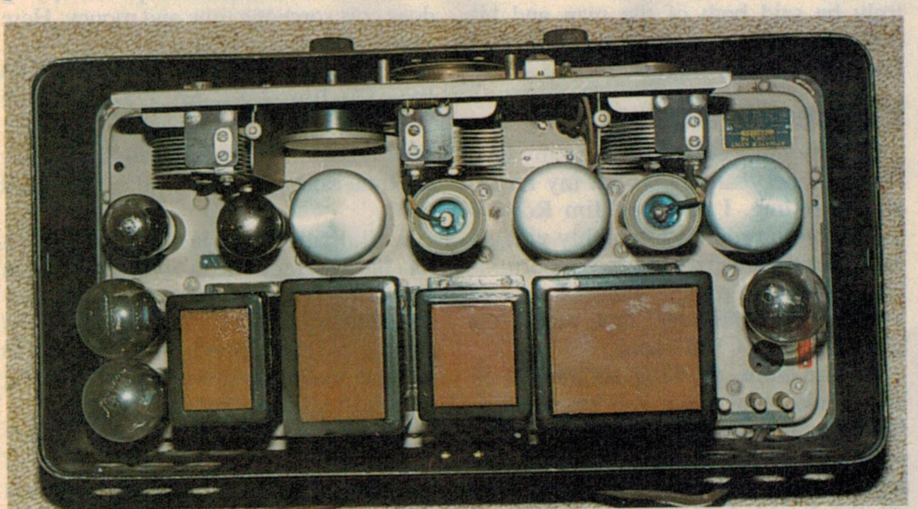


Fig.3: The interior of the model 55 with the valve cover removed. Of special interest are the belt coupled tuning capacitors, a transition between the earlier independent controls and the familiar common capacitor shaft. One of the belts is visible at top right.

VINTAGE RADIO

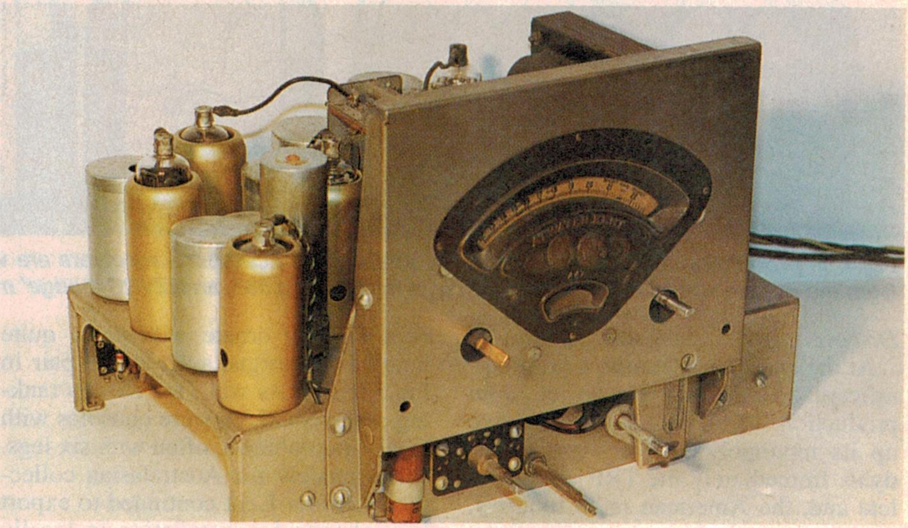


Fig.7: The 1934 model 447 chassis has some features found more often in a communication receiver, including continuous coverage from 550kHz to 23MHz in four bands. The RF stage is used on all bands and each band has an oscillator padder, ensuring accurate dial readings and tracking.

time later, the Bendix Corporation bought one of the factories.

After the closure Arthur Atwater Kent established a real estate business in Florida and then moved to Bel Air, California. There he built a 32-room mansion on top of the highest hill in Los Angeles, called appropriately Cappo de Monti. Here he lived in what he referred to as 'the simple life on a grand scale'.

He was a vegetarian, but entertained lavishly. Ever the technician, he also loved tinkering with his large fleet of cars. It is said that he never liked to use the same vehicle two days in succession! He died worth $8.5 million in 1949. It can truly be said both of the man and his radios, that they don't make either of them like that any more!

It's farewell, too...

This month's column will be my last. Nearly nine years ago, with my retirement pending, I accepted Jim Rowe's invitation to produce a monthly vintage radio series. I welcomed the opportunity to present to a wide range of readers some of the heritage that radio has acquired in just 100 years.

At one time, to show an interest in early radio equipment was regarded as being a little eccentric. Why worry about obsolete technology, when exciting new developments were appearing all the time? Attitudes have changed during the last decade and there is now a general appreciation of the significance of our industrial history.

An indicator of the active growth of interest in our radio past is the increase in membership of our vintage radio societies during recent years. In 1988, the Historical Radio Society of Australia had a membership of 300. Now it has more than doubled to over 700, and in the same period an encouraging growth has been registered by the New Zealand Vintage Radio Society.

I have mentioned previously that membership of these societies has benefits, These include receiving their quarterly magazines and access to data and circuit copying services. Do remember though, that when making inquiries please include an SAE and that photocopying does cost someone time and money. Here once again are the addresses:

Historical Radio Society of Australia Inc., PO Box 2283, Mt Waverly, 3149 Victoria.

New Zealand Vintage Radio Society, c/- 20 Rimu Road, Mangere Bridge, Auckland 1701.

Well, that's about it. I have derived a lot of satisfaction in presenting this series. I have been very encouraged by all the many readers who have taken the trouble to correspond with me and to provide material, and offer my grateful thanks to all concerned.

Next month Roger Johnson, a prominent member of the Adelaide Group of the HRSA, will take over the column with a new perspective. Roger is both knowledgeable and dedicated, and I am sure that readers will find his Vintage Radio columns both interesting and informative. ❖

THE SERVICEMAN

(Continued from page47)

But I was intrigued to know which component was the culprit. So a quick once over with a meter seemed to indicate that R610 was the villain. There is also a capacitor across this network and this could have been leaky but the meter seemed to say no.

There was nothing to indicate why the resistor was faulty. It wasn't burnt or anything like that. And because it was in a series parallel circuit, the meter reading wasn't all that accurate. I should have unsoldered the resistor, or disconnected the circuit from the rest of the set, to make a detailed study but I just couldn't afford the time.

So that is where it will have to stand. Every indication is a low value resistor, something I have never encountered before. Has anybody else had a similar experience?

Well, that's all for this month. We still have a few contributions for next month, but there's room for a lot more. See what you can do. ❖

EXPERIMENTING...

(Continued from page83)

Normally you shove a voltage in at this point to get the 555 to do something. But this time, we're using the 555 to control our circuitry, to control it again in a more roundabout way.

Since the IC has a three-equal-value resistor string inside it, we know that at 15V, each of those resistors will have 5V across it. Since Q1 has a 0.6V drop across its base-emitter junction, we know that there will be 4.4V across resistor Ra. Pick the resistor and you'll know the current level.

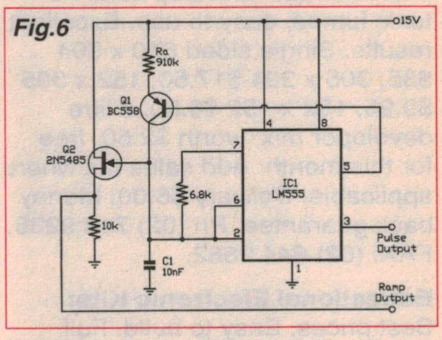
The time constant of this circuit is approximately 1.1 x Ra x C1. As with most 555 circuits, this one is supply independent so you can use any supply rail that the 555 timer will work comfortably from.

The output uses an N-channel JFET to buffer the ramp or 'sawtooth' output signal. This is so that you won't affect the frequency by putting a load on the output. The input impedance of the JFET is extremely high, so it doesn't affect the timing or frequency of the circuit.

The output pulse waveform at pin 3 corresponds to the falling edge of the waveform.

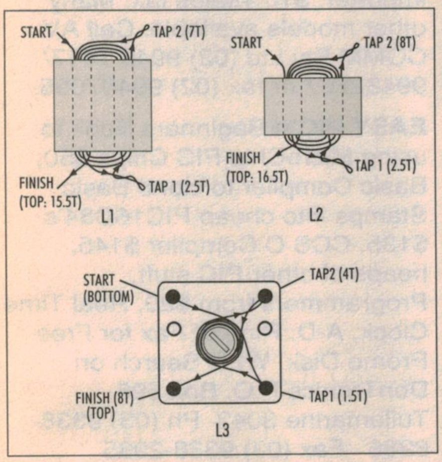
With the 6.8kΩ resistor in place, there is somewhat of a sloping falling edge on the ramp; but this is needed if you require a sync pulse out of pin 3. If the sync pulse isn't necessary, you can short out the 6.8kΩ resistor and you'll get a vertical falling edge on the ramp output.

Fig.6



That's where we leave the 555 timer for the time being. Next time, we'll start looking at digital logic and start looking through the maze of 4000-series CMOS ICs — and of course, some more circuits for you to try out. ❖

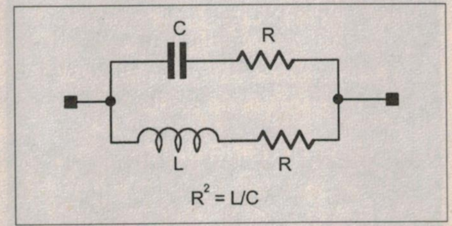
NOTES & ERRATA



Active Antenna for HF (December 95): Some readers had difficulty in winding the coils, from the text description given. The accompanying diagram should make things clearer.

Pocket Sampler (August 96): Pins 2 and 3 of SW1a are shown transposed in the overlay diagram on page 59 — the right-hand pin labeled 3 in the overlay should connect to the centre pole of the switch. The circuit diagram is correct.

Information Centre (August 96): A glitch in our DTP system caused the incorrect diagram to be printed for Fig.1. The correct diagram is shown here. Our apologies for the error.



Steam Whistle for model boats and trains (June 96): The value of R4 and R5 should be 47k, not 4.7k as shown in the schematic and parts list.

Note that the whistle may still work with the incorrect values, but the oscillators may tend to cut out at lower frequencies.

Low Cost Model Train Controller (November 95): Excess current can flow through D5 if both VR1 and VR2 are set to minimum resistance and both the 'Stop' and 'Go' buttons are pressed simultaneously. In this unlikely situation, D5 can burn out, causing the controller to lose its 'inertia'. A 1k resister placed in series with the wiper of VR1 will protect this diode, while while not interfering with the normal operation of the controller. ❖

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Amidon Ferromagnetic Cores: For all RF applications. Send business size SASE for data/price to RJ&US Imports, Box 431, Kiama NSW 2533. Agencies at Geoff Wood Electronics, Sydney; Webb Electronics, Albury; Assoc TV Service, Hobart; Truscotts Electronic World, Melbourne and Mildura; Alpha Tango Products, Perth; Haven Electronics, Nowra: WIA Equipment Supplies, Adelaide.

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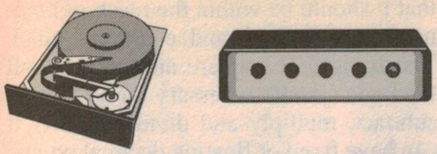

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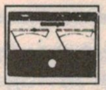

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50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Here we feature some items from past issues.

September 1946

Citizens' Radio: The bad weather which recently isolated the Mount Buffalo chalet from the rest of the world illustrates the value of radio communications to the average citizen, when frequencies are made available for private enterprises.

The time is fast approaching when the requirements of such citizens must be given serious consideration by the authorities who control the allocation of frequencies. The use of the ether is something which should be allowed to provide, where appropriate, the same facilities as are now available by means of the ordinary telephone when it is impractical to use these facilities.

In the case of the Mt Buffalo chalet, because of its elevated situation, UHF transmissions would probably be quite practicable with inexpensive apparatus.

Midget Trimmers: Philips Electronic Industries are now carrying good stocks of their air dielectric trimmers. Assembled on a central ceramic rod, the trimmers incorporate no less than seven concentric cylinders, which interleave as the moveable element is rotated. The capacitance range is from 3 to 30mmfd.

The trimmers are already in demand for test equipment and should be ideal for use in shortwave receivers.

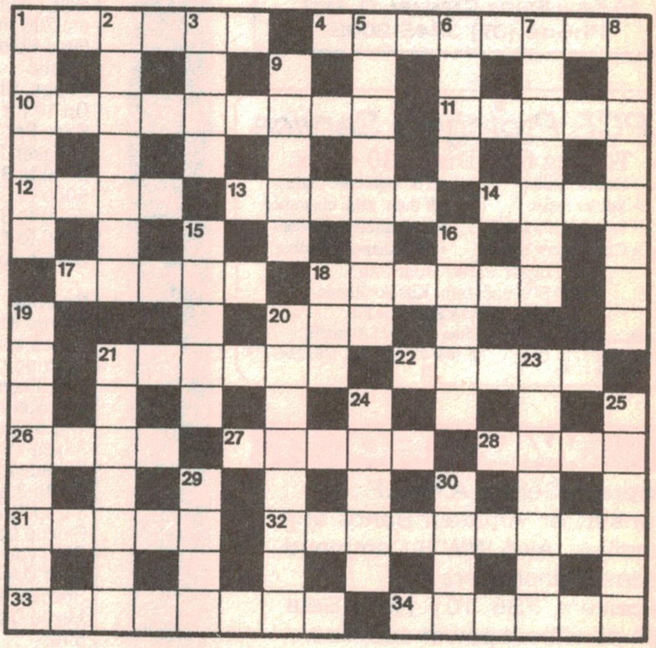
September 1971

IC Slide Rule: Texas Instruments is planning to introduce into the UK later this year a new IC that could replace the slide rule, according to the company's marketing manager. When coupled with a suitable display, the company considers that it should be within the reach of businessmen, students and engineers alike. The IC is 0.21" square and contains all the logic circuits necessary for a full add, subtract, multiply and divide facility. It can have fixed or floating decimal points, and can provide output coded for an eight digit, seven-bar display. The chip is in a low cost, 28-pin package.

Vertical deflection IC: An entire vertical deflection system for monochrome or large screen colour TV receivers has been integrated on a single semiconductor chip by Motorola Semiconductor Products Inc., USA. Known as the XC1390, it includes the oscillator, output stage and flyback sections in a single plastic 'winged' package. In addition, the design eliminates the need for the usual output transformer and linearity control. It uses a current drive to give a scan current which is independent of deflection yoke impedance variations.

Other features of the XC1390 include built-in fault protection, a squared retrace pulse for effective blanking and independent external vertical hold and vertical size controls. Within the IC package, the chip 'ground' is electrically connected to the 'wings' of the case, allowing both thermal and electrical bonding to be accomplished simultaneously. ❖

EA CROSSWORD



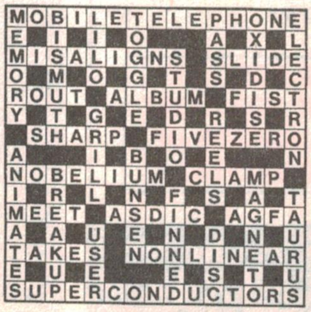
ACROSS

1 Control at a distance. (6)
4 Section of an amplifier. (5,3)
10 Temporary signal. (9)
11 System of code. (5)
12 Satisfying criteria for accuracy. (4)
13 Compact form of data storage. (1,1-3)
14 Interaction of waves. (4)
17 Unit of attenuation. (5)
18 Circuit configuration. (6)
20 Satellite based global navigation system. (1,1,1)
21 EA's Newsletter is from Silicon ... (6)
22 Type of noise. (5)
26 Free from contamination. (4)
27 Visible manifestation of current. (5)
28 Small office, home office. (4)
31 Some switches are sensitive to this. (5)
32 Engaged in productive activity. (9)
33 Bifurcating component. (8)
34 The physical universe. (6)

DOWN

1 Turn about an axis. (6)
2 Determine physical characteristics. (7)
3 Check operation. (4)
5 Valves. (8)
6 Computer-based pastime. (4)
7 Aiming points. (7)
8 Component of complex sound. (8)
9 Flexible parts of certain switches. (5)
15 Divisions in mobile telephone network. (5)
16 IR image intensifiers enhance vision. (5)
18 Designation of intelligence satellite. (3)
19 Calculates. (8)
20 Instrument for detecting rock vibrations. (8)
21 Said of an unreal image. (7)
23 Radioactive metal, atomic number 90. (7)
24 Central colour of sunlight spectrum. (5)
25 Extended phenomena in Space. (6)
29 Launch of a satellite, etc. (4)
30 Defence organisation. (4) ❖

SOLUTION TO AUGUST 1996:



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IREE'S AWARD OF HONOUR PRESENTED TO NEVILLE THIELE

FIRMS UNVEIL NEW 'FLASHPIX' TECHNOLOGY FOR USING & SHARING ELECTRONIC IMAGES

NATIONAL RESURRECTS FAIRCHILD SEMICONDUCTOR

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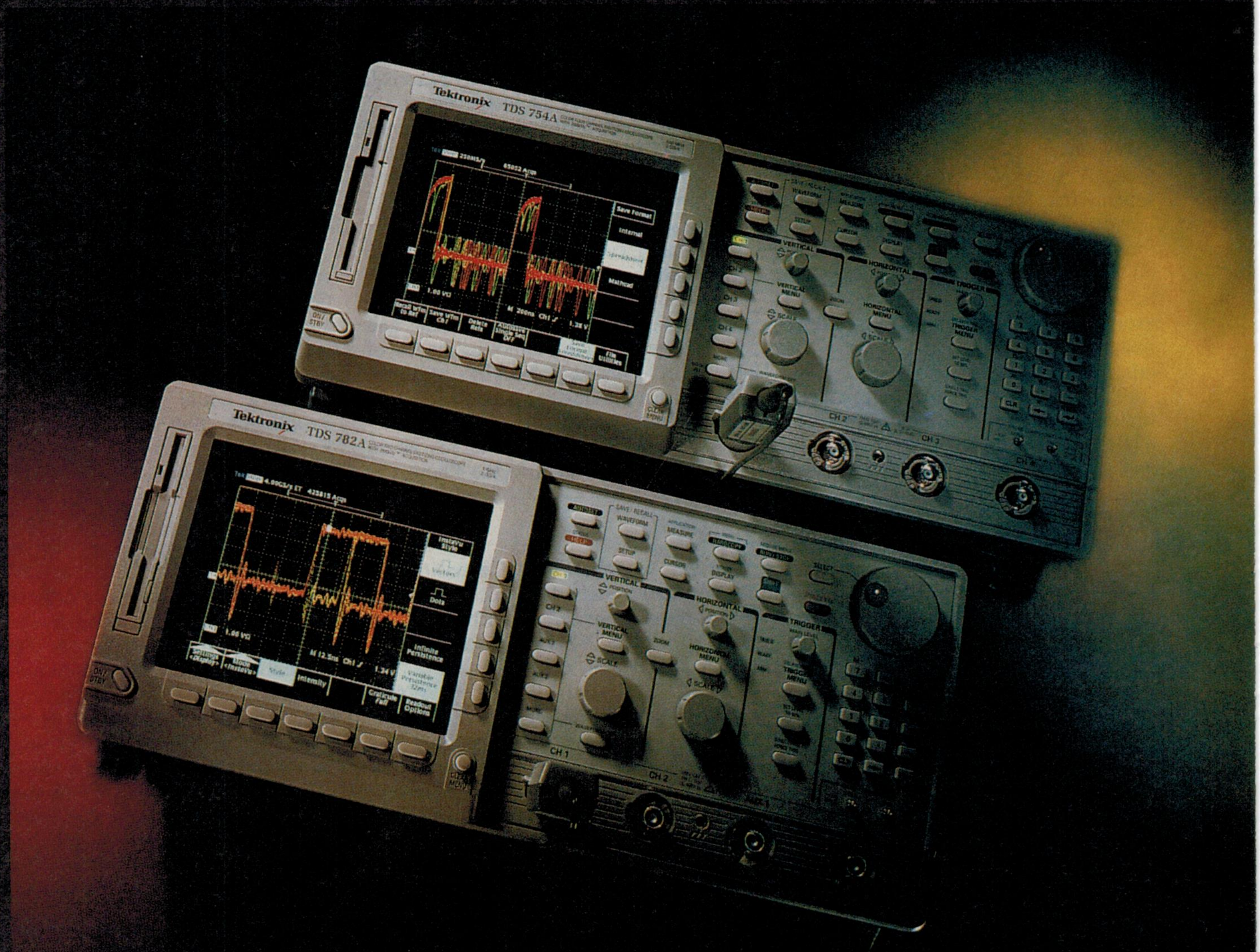


TEKTRONIX ADDS TWO NEW MODELS TO ITS HIGH-END 'INSTAVU' FAMILY OF FAST RESPONDING, COLOUR DISPLAY DSO's: THE TDS782A, WITH TWO 1GHz CHANNELS AND 2GS/s SAMPLING, & THE TDS754A — WITH FOUR 500MHz CHANNELS AND 1GS/s SAMPLING

NEWS HIGHLIGHTS

FIRMS UNVEIL NEW IMAGE ARCHITECTURE

Kodak, Hewlett-Packard, Live Picture and Microsoft have unveiled a new architecture they have jointly developed for using and sharing electronic images on computers, dubbed 'FlashPix'. The new technology is expected to change the way people will work with pictures, and has been awarded the *Byte* magazine 'best technology' award at COMDEX in Chicago.

The FlashPix architecture enables the use of high-quality images which can be manipulated as easily as the low-resolution image files typically on the World Wide Web today. Pictures can burst onscreen, transform rapidly when edited, move quickly over on-line services and look impressive coming off the printer. At the same time the technology to achieve this can be hidden from end-users, freeing them from having to select image resolutions, colour options and other technical details.

Flashpix is compatible with standard multimedia PCs — a 486 computer with 8MB or (preferably) 16MB of RAM, or an equivalent Macintosh platform. FlashPix images won't require additional RAM or hard disk space.

FlashPix will support images of any size, captured at any resolution. Images in FlashPix files are stored at multiple independent resolutions, and each resolution is sub-divided into square tiles. These features allow applications to select the appropriate resolution a user needs for a selected procedure, and to access directly the specific areas of an image needed for the operation being performed. An edit, layout choice or other use of an image, called an 'image view', is stored as a small script separate from the image data itself. The script and image data are wrapped inside an OLE structured 'storage container'. Structured storage enables software to easily store a variety of information types such as scripts, image data, ownership information, colour management data, etc all in one convenient single file.

Kodak owns the FlashPix specification and reference implementation, and will take the lead in promoting the use of FlashPix technology. FlashPix will provide an open industry standard for digital imaging.

"This new architecture serves as an excellent complement to the Photo CD industry standard. The Photo CD system remains an ideal solution for storing and archiving photographic images, while the FlashPix architecture is designed for using and sharing digital images of all types on computers and across networks", said Brendan Lovelock, business unit manager, Digital and Applied Imaging division, for Kodak Australia, New Zealand, South East Asia.

In addition to the developers, other leading companies — including AccuSoft, Apple, Broderbund Software, Canon, Corel, Fuji, IBM, Intel, Macromedia, MetaTools, Object Design, PictureWorks and Storm Primax — have announced their intent to support FlashPix technology, and some are expected to introduce products that support the new architecture by the end of the year.

A complete Software Developer's Kit, consisting of a reference implementation, implementation guide, a sample application and interoperability test suite will be available towards the end of the year. Interested developers can access a white paper with technical details on the format by visiting Kodak's home page at **http://www.kodak.com:/drgHome**.

IREE AWARD TO NEVILLE THIELE

At a reception and presentation on July 23 at the Australian Film, Television and Radio School, the Council of The Institution of Radio and Electronics Engineers Australia and the IREE Society Sydney Audio Group presented Mr A.N. (Neville) Thiele, FIREE, IEAust, FAES with their highest award, the IREE Award of Honour.

The IREE Award of Honour is presented only very occasionally, to those who have given 'long-standing and meritorious service to the promotion of The Institution's aims and objectives beyond the call of duty'.

Mr Thiele's personal achievements in the field of audio engineering are well known in Australia and around the world, of course. His work with Dr Richard Small on the design of loudspeaker enclosures has become one of the foundations of modern audio engineering. This plus his contribution to the affairs of The Institution of Radio and Electronics Engineers Australia over many years (both on the Council and as President) undoubtedly makes him a worthy recipient of this Award.

1M AUSSIES IN THE NET, SAYS TELSTRA

A survey of Internet activity conducted for Telstra has unveiled for the first time that more than one million Australians regularly use the Internet.

Telstra's research, undertaken by DBM Consultants in April, reveals the real level of Internet use in Australia based on research from more than 1000 households in Melbourne, Sydney, Brisbane and Canberra."The survey shows that the Internet has become a mass market almost before it was noticed", said Mr Bob James, Telstra's Group General Manager, Strategic Development. "And the remarkable news is that Australia is likely to be one of the top four countries in the world for Internet penetration. The gap between the leaders is just a few percentage points, and this could be made up in a matter of a few months."

Telstra's key Internet survey results

include the following:

- 7% of households have access to the Internet;
- 11% of all people over 15 years of age had accessed the Internet for one hour in the week prior to the survey;
- 16% of all people have accessed the Internet at some time; and
- 47% of households have a PC.

ABC SELECTS S-A VIDEO COMPRESSION

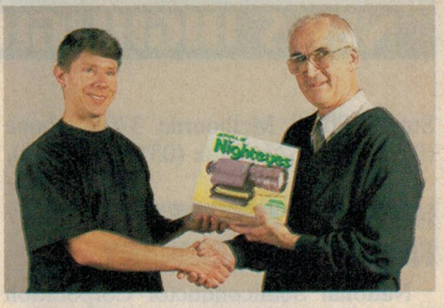
The Australian Broadcasting Corporation has selected Scientific-Atlanta's PowerVu digital video compression system to distribute its TV programming across Australia. The Scientific-Atlanta MPEG-2/DVB system will allow the ABC to increase its domestic satellite transmission capacity without leasing additional transponder space.

The ABC currently uses a half transponder on the Optus B1 satellite, to transmit one analog video signal at a time. Once PowerVu is installed, it will be able to transmit three high-quality digital video signals simultaneously using the same transponder space. All three digital video channels will be used for the ABC's interchange network.

The entire PowerVu digital compression network is scheduled for completion by mid November 1996. The system will include 19 encoders and 48 digital satellite receivers. To manage the system, the ABC ordered the PowerVu Command Centre 2000, S-A's UNIX-based network management, security and subscriber control system.

The ABC's senior broadcast engineers rated PowerVu the digital compression system with the best overall quality, after a series of blind tests with rival products.

DSE/APPLE NIGHTEYES CONTEST WINNER



We had an overwhelming response to the *Electronics Australia*/Dick Smith Electronics 'Win an Apple Nighteyes Night Viewer' competition, conducted in our June 1996 issue. Well over 500 entries were received, making the competition a big success. We'd like to thank everyone for their interest and effort.

There could be only one winner, though, and the judges chose the entry from Mr Gary Sinkovits, of Normanhurst in NSW. Mr Sinkovits (shown accepting his Apple Nighteyes from *EA* editor Jim Rowe) is a field service officer for Telstra, who also bushwalks and studies native wildlife in his spare time. He said he was delighted to win the night viewer, which will be used for observing animals at night.

VET TOPS LIST OF ANTI-VIRUS SOFTWARE

VET, the well-known antiviral software package developed by Melbourne firm Cybec, has topped the latest list published by respected industry magazine *Virus Bulletin*, scoring more points on the magazine's multi-factor rating system than products from its major competitors from the USA — including Symantec and McAfee. VET scored an overall average of 94.2, whereas products like McAfee's scored 89.0 and Central Point's scored 76.8. Australian product Virus Buster scored 67.1.

"This result is a clear indication that if you work smart, you get the results", said Nicholas Engelman, Cybec's Technical Manager. "The world is often surprised when Australian companies perform well. This result is no surprise to us. It is the end product of six years of good design and plain hard work."

Cybec's resident virus expert, Jakub Kaminski, has been recognised for his work by being invited to be technical editor for *Virus Bulletin*.

Cybec has recently opened an office in Sheffield, UK, to provide improved support for British users of VET. The office is being managed by Ms Jill Memmott, formerly support manager at Sheffield Hallam University.

TECHNICAL SKILLS NEEDED

TADVIC (Technical Aid to the Disabled) is currently in desperate need of volunteers to design and make equipment for people with disabilities. According to publicity officer Mary Jurus, the organisation is looking for people with practical engineering skills, and believes that *EA* readers may fit that category.

TADVIC is a non-profit organisation which operates throughout Australia, providing equipment to disabled people of all ages where there is no commercial option available. The work is done by volunteers and clients only pay for materials, thereby minimising their costs.

Recent projects completed by TADVIC volunteer workers include designing and building a head support system for a young client with cerebral palsy, to allow her to use a computer and communicate conveniently; designing and building a lifting device for a client with muscle weakness; and modification of a CB transceiver to allow operation by mouth, by a quadriplegic client.

Readers interested in offering their skills and time to TADVIC as volunteers can contact them at 79 Buckhurst

The traditional 'Buttinski' telephone set used to test lines and circuits can either corrupt today's data transmissions, or not even make them apparent. These new DigiAlert sets from UK firm Chesilvale Electronics detect digital signals and prevent technicians interrupting live circuits. (For information phone +44 (0) 1633 223552)

Street, South Melbourne 3205; phone (03) 9254 5625 or fax (03) 9696 5190.

NATIONAL RESURRECTS FAIRCHILD SUBSIDIARY

National Semiconductor Corporation has formed a new subsidiary organization consisting of its family logic, memory and discrete businesses, to be called Fairchild Semiconductor. It also named Kirk Pond, a National executive vice president, as president and chief executive officer of Fairchild.

"This new structure will unlock the value inherent in all the product lines of both companies, by allowing each to be managed for optimum success", said Brian Halla, National's chairman, president and chief executive officer.

"National Semiconductor's strategy", Halla added, "is to focus on applications and products for moving and shaping information. The core of the strategy is excellence in designing, manufacturing and marketing analog and mixed signal products. Because of this, we feel it makes sense to separate out our family logic, memory and discrete businesses into this new subsidiary. In doing so, we will allow each entity to pursue a total business strategy tailored to its unique needs."

National sites that will become part of Fairchild Semiconductor includes the 4", 5" and 6" wafer fabrication plant in South Portland, Maine; the wafer fabrication plant in West Jordan, Utah; and the test and assembly plants in Cebu, the Philippines, and Penang, Malaysia.

SIMOCO ACQUIRES PHILIPS MOBILE

A new company called SIMOCO International Ltd has acquired the business of Philips Telecom — Private Mobile Radio from Philips Electronics. SIMOCO International is backed by venture capital group CINVen.

The transfer includes the business of Philips Mobile Communication Systems in Australia, which now becomes SIMOCO Pacific Pty Ltd, with the additional responsibility for the Asia Pacific Region. SIMOCO Pacific's head office will remain in Melbourne and Peter Bentley, formerly General Manager of Philips Mobile Communication Systems, becomes the SIMOCO Pacific Managing Director for the Region.

Mr Bentley said "Our staff are confident about the acquisition and the continuation of our commitment to our customers. Our strong business position and substantial recent orders indicate further growth potential. While we will maintain our support to analog and trunking technologies — which have a good service to offer for many years to come — we are planning for exciting developments with the introduction of new digital standards."

SIMOCO International is led by Ian McKenzie, an Australian and former Managing Director of the Philips Mobile Radio international business. A recognised authority on mobile communications, Mr McKenzie will be based in Cambridge as SIMOCO's Executive Chairman. Philips Electronics NV retains a minority equity in the new company.

US, JAPANESE ENTRIES FOR SOLAR CYCLE RACE

Teams from Japan, Australia and the USA have lodged the first official entries in the Sensational Adelaide 1996 World Solar Cycle Challenge. The event, to run in conjunction with the fourth World Solar Vehicle Challenge in October this year, will demonstrate solar-assisted human powered vehicles with immediate marketing potential.

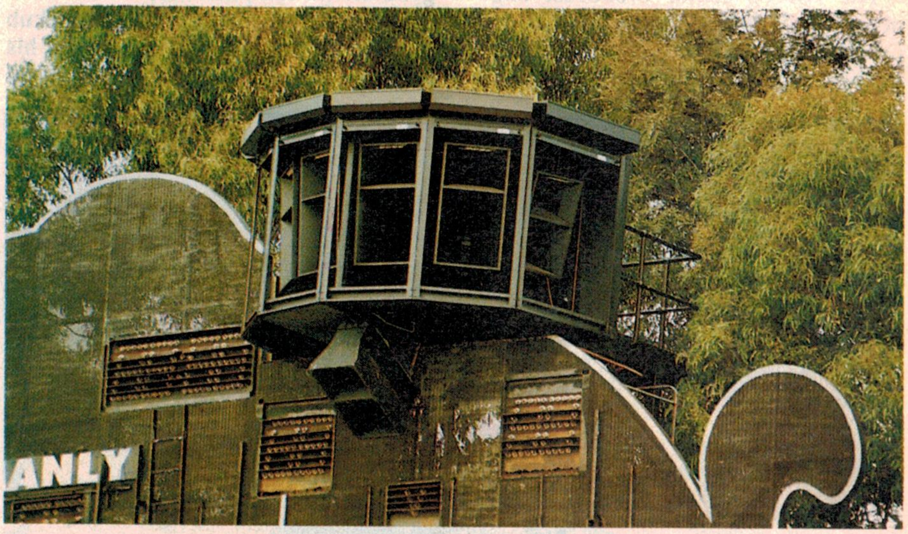
Dr Paul McCready, the engineer responsible for the General Motors Sunraycer's victory in the inaugural 1987 World Solar Challenge, has lodged the first official entry for Aerovironment Inc. from the USA. Dr McCready's design was used as the basis for over half the vehicles entered in the next event held in 1990. Also hailed as the world pioneer in man powered and solar powered flight, his many achievements have been integral in the short history of solar mobility.

The success of the Sunraycer in 1987 led GM to develop the Impact, the world's first production electric vehicle soon to be available in the USA. Aerovironment's entry in the Solar Cycle Challenge may well form the basis of a production electric cycle with commercial viability.

Tennen Denryoku from Japan will race a standard production bicycle with electric power assist. The batteries carried by entries in the Standard Production Bicycle class may be charged by both a solar panel carried on board and by a solar panel mounted on the roof of a support vehicle. When teams change riders, they will be permitted to replace the batteries. This is the 'Solar Service Station', a concept which could be further developed to service the needs of future electric vehicle developments.

The first entry in the aerodynamic class, and Australia's first representative, is a three wheel design from SUNstrike based in the ACT.

The race organisers expect to receive further entries from the USA, Australia and Japan, and if current interest is



The Panthers Stadium in Penrith, west of Sydney, has installed this Bose Panaray LT single point source array loudspeaker system to provide high SPL coverage of the stadium during Rugby League matches. It's located 10m above ground level, and was installed by The P.A. People.

maintained, Europe will also be well represented. The race will start in Darwin on 27 October 1996 and will finish in Adelaide on November 4.

DOLBY TO SPEAK AT AES CONVENTION

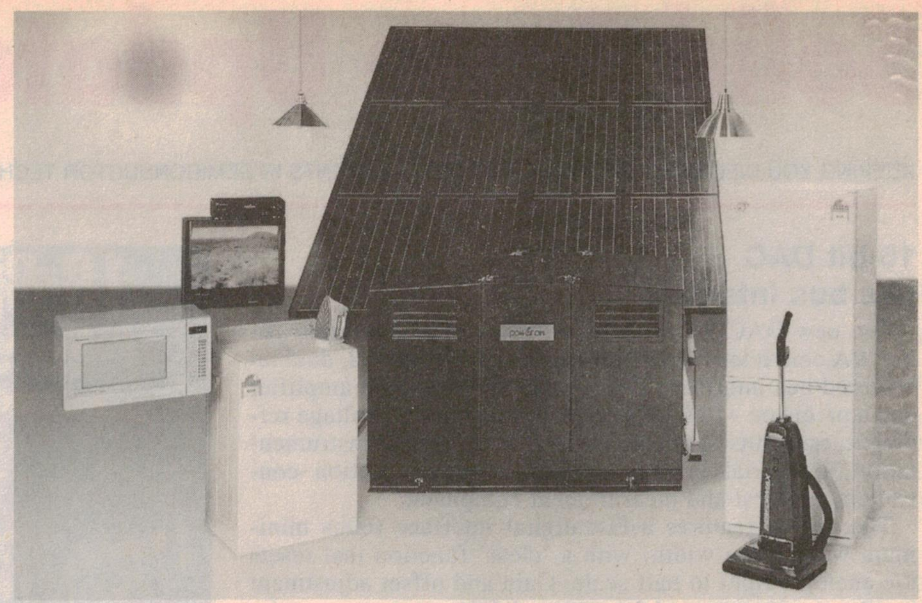
Dr Ray Dolby, founder and chairman of Dolby Laboratories Inc and a household name in audio, will be Special Guest and Keynote Speaker at the forthcoming 6th Australian Regional Audio Engineering Society Convention to be held September 10-12 at the World Congress Centre in Melbourne. Dr Dolby will be available to meet and talk with participants throughout the convention.

Ray Dolby was born in Portland, Oregon, USA in 1933. From 1949-52 he worked on various audio and instrumentation projects at Ampex Corporation, where from 1952-57 he was mainly responsible for the development of the electronic aspects of the Ampex video tape recording system. In 1957 he received a BS degree from Stanford University, and upon being awarded a Marshall Scholarship and a National Science Foundation graduate fellowship, he left Ampex for further study at Cambridge University in England. He received a PhD Degree in Physics from Cambridge in 1961, and was elected a Fellow of Pembroke College (Honorary Fellow, 1983).

In 1963, Dolby took up a two-year appointment as a United Nations advisor in India, then returned to England in 1965 to establish Dolby Laboratories in London. Since 1976 he has lived in San Francisco, where his company has established further offices, laboratories, and manufacturing facilities. He holds more than 50 US patents, and has written papers on video tape recording, long wavelength X-ray analysis, and noise reduction.

Dolby is a Fellow and past president of the Audio Engineering Society, and a recipient of its Silver and Gold Medal Awards. He is also a fellow of the British Kinematograph, Sound & Television Society and of the Society of Motion Picture & Television Engineers, which has awarded him its Samuel L. Warner Memorial Award, Alexander M. Pontiatoff Gold Medal, Progress Medal, and Honorary Membership. The Academy of Motion Picture Arts and Sciences voted him a Scientific and Engineering Award in 1979 and an Oscar in 1989, when he was also presented with an Emmy by the National Academy of Television Arts and Sciences.

Further information is available from convention organisers ICMS, of 84 Queensbridge Street, Southbank 3006; phone (03) 9682 0244 or fax (03) 9682 0288.



Energy Australia has launched the 'Power On' solar/diesel power system, designed to provide clean and reliable power to homes remote from the electricity grid. Typically it can provide up to 5.4kW with the diesel generator assisting. At an installed cost of around $30,000, it can often be cheaper than a grid connection.

NEXT 'ELECTRONICS AT WORK' FOR MELBOURNE

The success and industry acceptance of Australia's first national 'Electronics At Work' exhibition and seminars has ensured continuation of the event, which will now be held annually, alternating between Sydney and Melbourne.

The success of the inaugural event, staged at Sydney's State Sports Centre at Homebush Bay in June, demonstrated that "there was indeed a very real need for an event dedicated to the specific needs of electronics engineers and management", according to exhibition manager Debbie Cadet.

"Like the USA's Wescon and Germany's Electronika, Australia and the Pacific region have a requirement for their own major show which focuses entirely on electronics and is not cluttered with other peripheral products and issues," she said.

Cadet said planning for the 1997 event, to be held in Melbourne at the World Congress Centre on June 18 and 19, was well under way and already she had received 'a significant number' of exhibitor re-bookings for next year, as well as approaches for booth space from new prospects.

In conjunction with the exhibition, the event will again incorporate a conference and workshop program presented by the Australian Electronics Development Centre (AEDC). Executive director of AEDC Deborah Davis said the conference and workshops are currently being planned, and sessions are being designed to attract visitors with 'need to know' interest in current and new industry standards and will cover a variety of subjects including EMC. ❖

NEWS BRIEFS

- A training course ***Manufacturing and Design for Surface Mount Technology*** will be held on August 27-29 1996 at The Australian Electronics Development Centre, Broadmeadows Vic. Phone (03) 9302 1422 for details.
- A seminar titled ***Telecommunications, Beyond 1997*** will be held at the Hyatt Regency, Sydney on September 17-20, 1996. For details phone (02) 9954 5844.
- Ray Dolby, founder of Dolby Laboratories, is the keynote speaker at the ***6th Australian Regional AES Convention*** to be held on September 10-12, 1996 at the World Congress Centre Melbourne. For details phone (03) 9682 0244.
- ***PC 96 Melbourne*** will be held at the Melbourne Exhibition Centre, September 6-8, 1996. For details phone (03) 9867 4500.
- Analogic has appointed ***Obiat P/L*** as distributor for its range of data conversion products, power supplies and DAQ boards.
- ***CEDIA Australia*** has a new phone number: (02) 369 2717. The CEDIA Aisa Pacific Expo will be held at the Hyatt Regency, Kings Cross Sydney, February 7-9, 1997. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

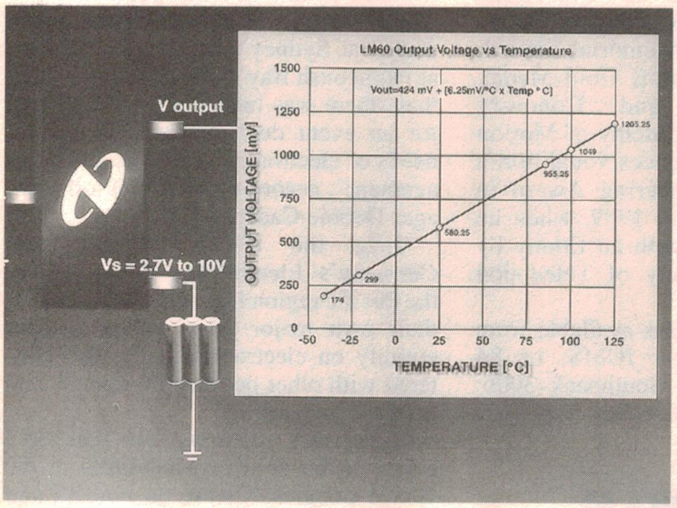
16-bit DAC has bus interface

The new DAC715 from Burr-Brown is a monolithic 16-bit D/A converter with a high-speed 16-bit parallel, double-buffered bus interface. The IC also has an output amplifier and a precision +10V temperature compensated voltage reference, and suits applications such as analytical instrumentation, industrial process control, robotics, motion controllers, and test and measurement equipment.

The device features a fast digital interface (60ns minimum write pulse width) with a 'clear' function that resets the analog output to half scale. Gain and offset adjustment inputs can be trimmed by external D/A converters or by potentiometers.

Key specifications include: 0 to +10V voltage output, 600mW max power dissipation, fast settling time (10us to 0.5 LSB), +/-12V to +/-15V extended supply range. It is available in 28-pin DIP and 28-lead SOIC packages, and is specified over the -40°C to +85°C operating temperature range.

For further information circle 271 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700, free call 1800 335 245.



TinyPak temp sensor

National Semiconductor has announced the newest member of its family of analog output temperature sensors. The device, type number LM60, comes in an SOT-23 TinyPak and operates from 2.7V. It has an output voltage scale of 6.25mV/°C, and is claimed to have an excellent linearity over a temperature range of -40° to +125°C. Because of its small size, the device is suitable for use in portable equipment or where space is at a premium.

Applications include temperature compensation for oscillator drift, and monitoring temperature change during battery charging. The sensor doesn't need any external signal conditioning, calibration, or correction look-up tables. National has an evaluation kit for the device.

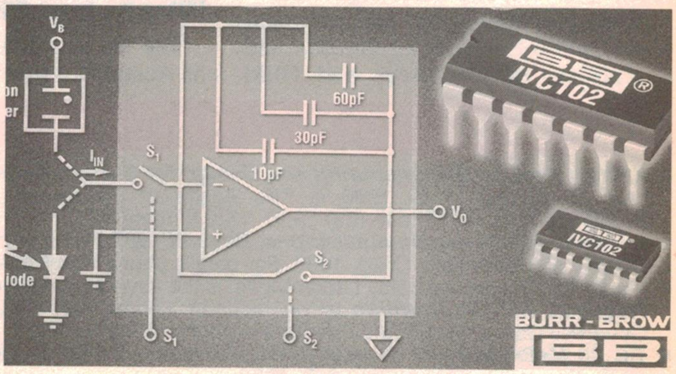
For further information circle 279 on the reader service coupon or contact National Semiconductor (Aust), Business Park Drive, Monash Business Park, Notting Hill 3168; phone (03) 9558 9999.

Switched-integrator transimpedance amp

Burr-Brown's new IVC102 is a precision FET input integrating amplifier with on-chip integration capacitors, and low leakage analog switches. The device integrates the input current for a user determined period, and holds the resulting voltage on the integrating capacitor.

The IVC102 is suited to amplifying low-level sensor currents from photodiodes, ionisation chambers, and other current/charge output sensors, as well as leakage current measurement. Applications include medical diagnostic instruments, industrial measurement, analytical and scientific equipment.

The amplifier can integrate a positive or negative input current, allowing a variety of sensor types and biasing techniques. Separate 10pF, 30pF and 60pF integration capacitors can be connected in combinations up to 100pF. External integration capacitors can also be used. TTL/CMOS compatible timing inputs control the integration period, hold and reset functions that determine the effective transimpedance gain, and reset (discharge) the integration capacitor.



The input bias current is typically 100fA, allowing measurement of extremely low input signal currents with a typical nonlinearity of 0.005%. The device is available in 14-pin plastic DIP and SO-14 surface mount packages, and is specified over the -40°C to +85°C industrial temperature range.

For further information circle 278 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700, free call 1800 335 245.

Audio attenuator has only 0.001% THD

A new Overture audio attenuator from National Semiconductor, type number LM1971, is claimed to offer the industry's highest level of fidelity for single-channel attenuation. It has a total harmonic distortion (THD) level of 0.001% (typ), a dynamic range of 110dB and is claimed to produce a 'pop-and-click-free' performance.

The device is suited for use in portable communications devices, conference phones, hearing aid devices or wherever board space requirements are tight.

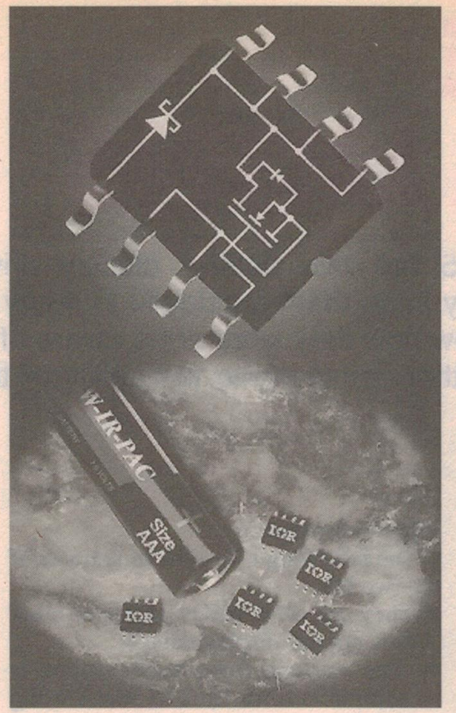
"Traditionally, single-channel audio attenuation could only be achieved with digitally controlled pots and resistors designed for industrial control applications," explained Edwin Leong, Business Centre Manager, Analog Division. "These devices, however, cannot match the high levels of fidelity found in a true audio attenuator."

The IC operates from a supply voltage range of 4.5V to 12V to meet the needs of low-voltage, portable communications equipment, and devices such as digital audio mixers and other professional equipment which require a higher dynamic range. The attenuator is offered in standard 8-pin surface mount and DIP packages.

For further information circle 273 on the reader service coupon or contact National Semiconductor (Aust), Business Park Drive, Monash Business Park, Notting Hill 3168; phone (03) 9558 9999.

FETKY for power converters

International Rectifier has developed a new power component that combines a HEXFET power MOSFET and a Schottky diode in a single S0-8 small outline package. Called FETKY, the new technology is claimed to save board space and reduce assembly costs in power converters and other power subsystems.



The new technology takes advantage of the reductions in MOSFET die size and on-resistance achieved by IR's recently introduced Generation-5 MOSFET process, as well as advances in packaging capabilities that reduce thermal resistance.

Initially, the FETKY family is targeted at power converter applications and will include two components — the IRF7422D2 containing a -20V, 90mΩ P-channel HEXFET power MOSFET and a 30V, 3A Schottky diode; and the IRF7421D1 containing a 30V, 35mΩ N-channel HEXFET with a 30V, 1A Schottky diode.

The use of FETKY components in DC-DC converters is claimed to reduce power drain, power dissipation and heat generation in converters. Use in a standard buck converter is also claimed to save up to 60% of board space.

For further information circle 272 on the reader service coupon or contact Hartec Ltd, PO Box 264, Box Hill 3128; phone (03) 9268 9000, free call 1800 335 623.

Damper diode for high end TV sets

Claimed as a world first, Philips has introduced a 1700V damper diode for TV and monitor deflection circuits in high performance TV sets and multisync monitors. The BY479X-1700 high voltage fast recovery diode can replace the two or more diodes currently required.

The diode is claimed to offer an improved performance due to a higher peak flyback voltage, plus savings in component and assembly costs. Key specifications of the diode are a repetitive peak reverse voltage of 1700V, a forward recovery voltage of 12V, and a forward recovery time of 200ns to a forward voltage of 5V. Switching losses are low enough to allow a single diode to handle the required power dissipation for line scan frequencies up to 64kHz.

The diode is recommended for use with Philips 1700V transistors type BU2722AF for 15" colour monitors, and BU2727AF for 17" monitors. It is packaged in a standard SOT186A plastic power package with an isolated mounting tab. Electrical isolation between the mounting tab and the diode lead-outs is an industry-standard 2.5kV.

For further information circle 274 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 805 4479.

1.8-2GHz 3V low noise amplifier

US based Alpha Industries has introduced a low noise amplifier, type AL102-12 that operates in the 1.8-2.0GHz band. The amplifier has a gain of 14.5dB, 1.8dB noise figure and a wide dynamic range. When operating from a single 3V power supply it draws around 3mA, making it suitable for battery powered systems. The amplifier comes in a small SOIC 8 package.

For further information circle 275 on the reader service coupon or contact Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066; phone (02) 418 6999. ❖

USING THE LM3914 & LM3915

The LM3914 and the LM3915 are two dot/bar display driver ICs produced by National Semiconductor. You've probably seen them employed in many electronic circuits and commercial equipment, but may not know how they work or be aware of their many features. This article presents a few simple circuits that demonstrate the ability of these two versatile and perhaps under-used ICs.

by SAMMY ISREB

When it comes to representing a changing analog quantity such as power output or volume, the obvious choice would be to use a panel meter — but meters do have their drawbacks. If the piece of equipment is going to be subjected to mechanical shocks or other rough treatment, a meter movement can be easily knocked out of alignment or even permanently damaged. Another problem is that they are usually quite expensive — sometimes the cost of the meter movement alone can exceed the cost of the rest of the circuit!

A digital readout is one answer, but it's hard to detect trends or changes in the signal level as you have to read and interpret the readout for each new reading.

Quite often, the best compromise is the LED 'bar graph' display, particularly when you only want an indication of signal amplitude rather than a precise measurement. The LM3914 and LM3915 were designed to make the job of adding a bar or dot readout to your design a simple one, with some circuits needing only a capacitor, two resistors and the IC itself to drive a row of LEDs.

Versatile ICs

Both the LM3914 and the LM3915 are 18-pin devices, and they have identical pinouts (see Fig.1). They are also almost identical in their operation.

Both the '14 and '15 sense incoming analog voltage levels and drive 10 LEDs or other low current output devices accordingly. The input is passed through a 10-step comparator with an externally adjustable reference, to drive 10 buffered outputs each capable of supplying 1 to 30mA into the load. The LM3914's outputs change in a linear sequence, whilst the LM3915 drives each of its 10 outputs using a 3dB/step logarithmic system. This makes it more suitable for displaying volume levels, as it more closely matches the ear's logarithmic response.

The following is is a list of features of the two ICs:

- They can drive LEDs, LCDs or other low current display devices.
- The current from each output is adjustable from 1mA to 30mA using just one program resistor.
- Multiple ICs can be linked together to provide displays of up to 100 steps.
- Alternative dot or bar mode display can be selected by connecting pin 9 to V+ or ground.
- The supply voltage can range over 3 to 24 volts while the IC maintains a linearity of less than 0.5%.
- The voltage reference of the internal 10 step comparator is adjustable from 1.2 volts up to 12 volts.
- The voltage inputs can withstand a voltage swing from -30 volts to +30 volts without damage to the IC.
- And being a linear device, the chips are very easy to interface with both TTL and CMOS logic ICs.

The LM3914

The LM3914 IC is best used when a visual display is needed in which the incoming signals are expected to be within a comparatively narrow range that can be covered in 10 linear steps. The amount of current that flows through each of the 10 LEDs can be adjusted by changing the value of R1 (see computer sound level meter circuit, Fig.3), with the current determined by the formula $I_{LED} = 12.5/R1$.

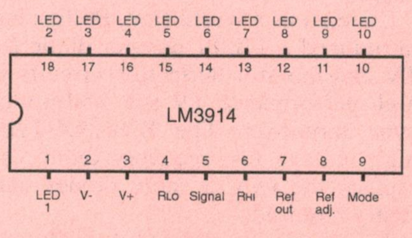


Fig.1

One useful feature of the LM3914 is that its on-board precision voltage source is designed to be adjustable, allowing you to define the input voltage at which the chip will light the tenth LED. The chip's reference voltage is a nominal 1.25V between pins 7 and 8, and this voltage is developed across the program resistor R1 in the following circuit. As we now have a constant voltage developed across a fixed resistor, we thus have a constant current flowing through the output set resistor R2, giving an output voltage of $V_{ref} = 1.25 \times (1+R2/R1)$.

This means that the voltage change on the input needed to light the next LED is dependent upon the value of R2.

Another feature is that multiple LM3914s (as well as the LM3915s) can be linked together in dot mode to form displays of up to 100 steps. A basic circuit showing this is Fig.2. This circuit senses that the first LED of the second chip is on and switches off the last LED of the first chip. Note that Fig.2 does not include reference circuitry, which is left to the user to design.

Sound level meter

On the computer I am using at the moment to type this article, there is a sound card connected to a CD-ROM drive which I use to play audio CD's. The line output of the CD-ROM drive drives an amplifier and speakers, which leaves all outputs of the sound card free. When my craving for a sound level meter would not go away, this circuit was developed (Fig.3). It was built for practically nothing, takes its power from the computer, and is calibrated using the mixer software on the computer.

Whilst a LM3915 is normally used for an audio power meter because of its log-

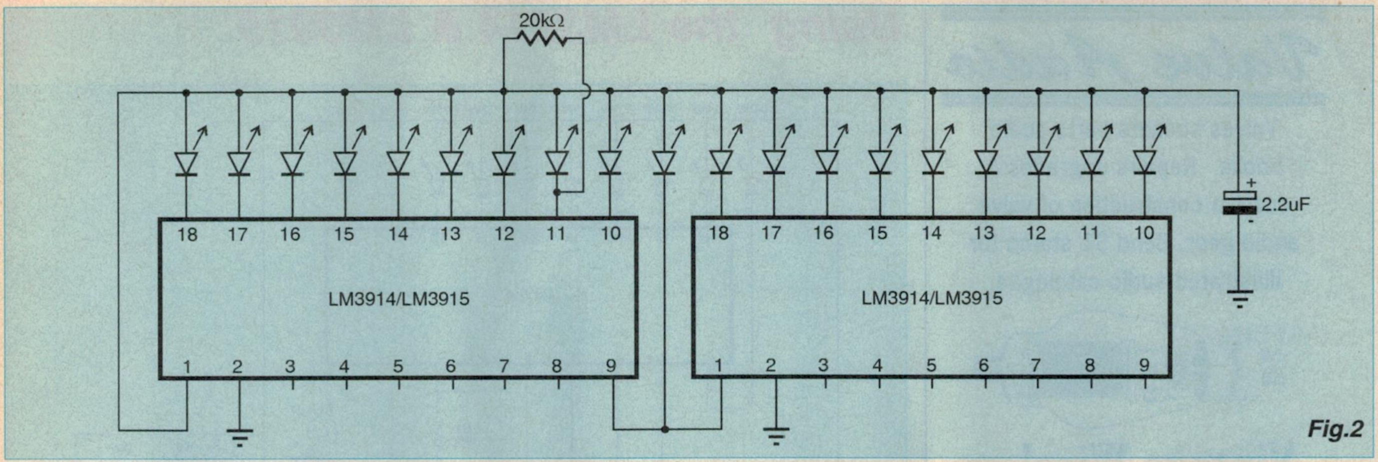


Fig.2

arithmic response and thus wide dynamic range, the LM3914 is used in this case because the low power levels present from the computer output can easily be shown on a linear scale.

The circuit draws its power from the games port, running off the +5V supplied by pin 15. As we have a maximum of five volts to work with, the reference voltage of the IC must be set to slightly below this. In this case the reference was chosen to be 4V. As well, the output current to each LED was set to around 20mA for a nice bright display.

To determine the values for R1 and R2, two formulas were used. These calculations can be used as a guide when designing circuits using the LM3914 or LM3915 ICs.

Firstly the current supplied to the LEDs is chosen:

$I_{LED} = 12.5/R1$.

So 20mA = 12.5/R1, thus R1 = 625Ω or 620Ω, the closest value resistor available.

Next the voltage reference is set to 4.0 volts. Note that R1 is already selected to be 620Ω:

$V_{ref} = 1.25 \times (1 + R2/R1)$.

So $4 = 1.25\ (1 + R2/620\Omega)$. Thus R2 = 1364Ω, or 1.3k as the closest resistor value available.

The circuit can be built on a PCB or piece of Veroboard (two should be built for stereo display) and looks good housed in a zippy box.

Once this is done, it can be calibrated by playing a CD and using the mixer program on the computer to adjust the volume level until the display looks like it is giving a proper reading of the sound level. The volume of the music won't be altered, as the CD line out is independent from the mixer.

The circuit can be switched from bar mode to dot mode by the mode control switch connected to pin 9. The LEDs can be of any type, but having LEDs 1-5 green, LEDs 6-8 yellow, and LEDs 9-10 red looks much more professional.

The LM3915

The LM3915 should be used when a visual indication is needed for an input signal with a wide dynamic range, as it uses a logarithmic scale (3dB/step). It also features the same adjustable reference voltage and LED current as the LM3914 shown above. This makes it ideal for applications such as audio power meters, sound meters, light meters, and RF signal meters, just to name a few.

Two typical applications of the LM3915 which are featured here are an Audio Power Meter, an application in which the LM3915 has been used for in countless situations, and a Vibration Meter — a rather novel circuit.

Audio power meter

Whilst the sound level meter shown above might work well, there is no substitute for an audio power meter on a hifi system. This circuit measures the power output of your amplifier in ten 3dB steps, from 0.2 watts right up to a healthy(?) 100 watts. Like all other circuits using the LM3915 and LM3914, it is switchable from dot to bar mode using the mode switch. The value of R4 is dependent upon the impedance of the loudspeaker connected to your amplifier, and its value can be determined from the table.

A rather neat way of building this circuit is to build it into your amplifier. The power for circuit is easily derived from the DC power rails of the amplifier by using a 12 volt regulator, as nearly all amplifiers I have come across use a supply voltage of over 12 volts. Just remember to mount the regulator onto the heatsink of the amplifier. Also remember that you will probably need to build two of these circuits, as the circuit shown is for only one channel.

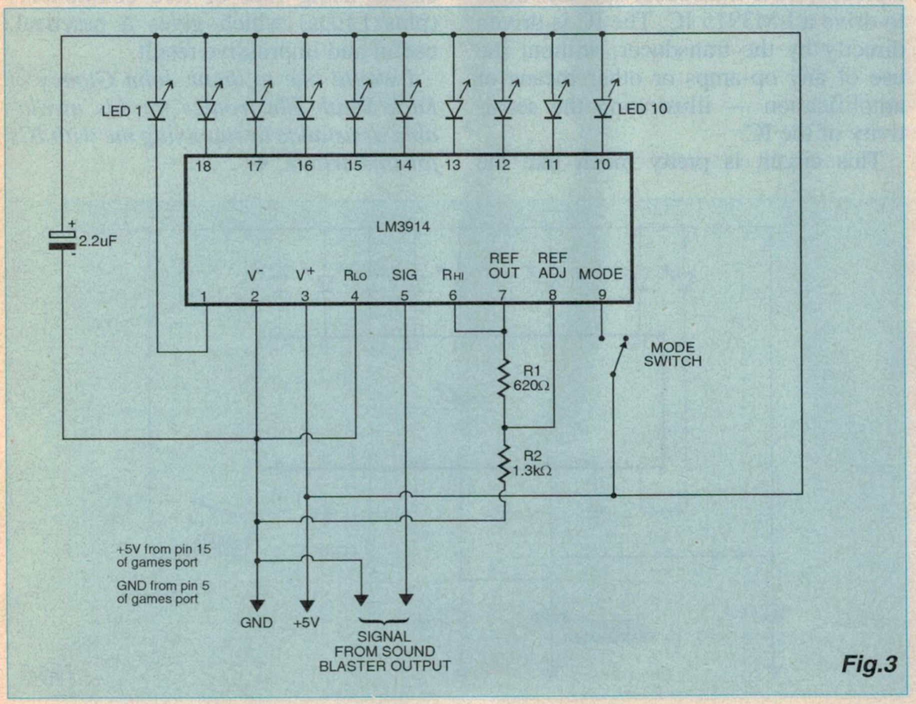


Fig.3

Using the LM3914 & LM3915

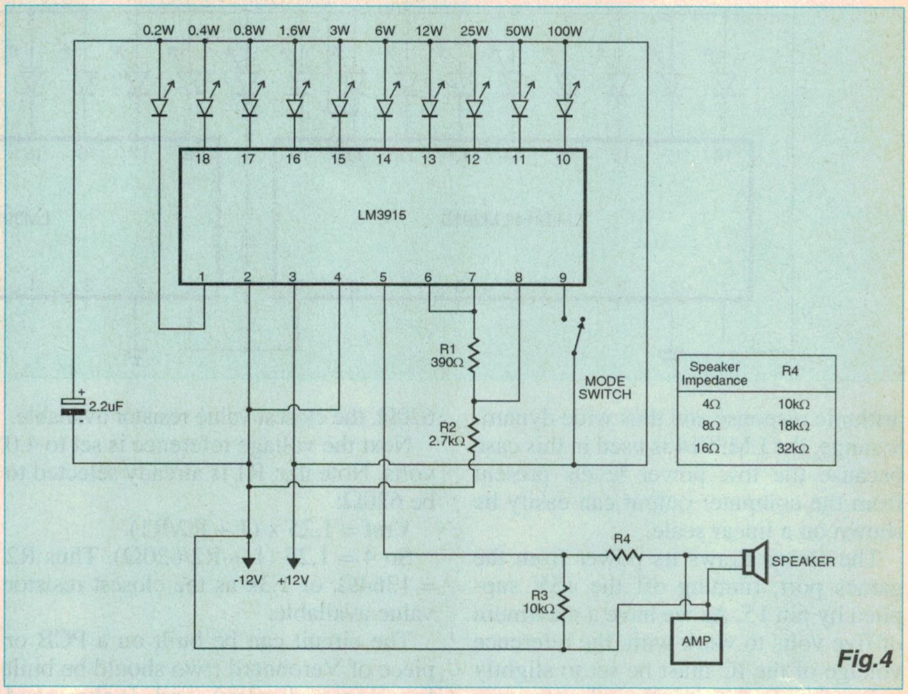


Fig.4

Vibration meter

As I write this article, the Albert Park Grand Prix is being run. This circuit is dedicated to all those Albert Park residents who are worried about the vibrations around their houses. While I can't guarantee that it will detect racing car vibrations, it is fun to play with during the advertisements between the races. (You can even use it as a stethoscope — beat that for an application!)

This circuit senses vibrations through a piezoelectric transducer and uses them to drive a LM3915 IC. The IC is driven directly by the transducer, without the use of any op-amps or other means of amplification — illustrating the sensitivity of the IC.

This circuit is pretty much like the Audio Power Meter in its operation, apart from the different reference voltage setup. It measures from about 50mV to around 1 volt in 3dB steps. Like the other circuits it can be switched from dot to bar mode by using the mode switch.

Many uses

As you can see, the LM3914 and LM3915 lend themselves to many applications, and as these circuits demonstrate, it's a simple matter to design a circuit using four or five components (plus LEDs) which gives a practical, useful and impressive result.

I would like to thank John Glancy of Dick Smith Electronics for his invaluable assistance in supplying me with ICs for this article. ❖

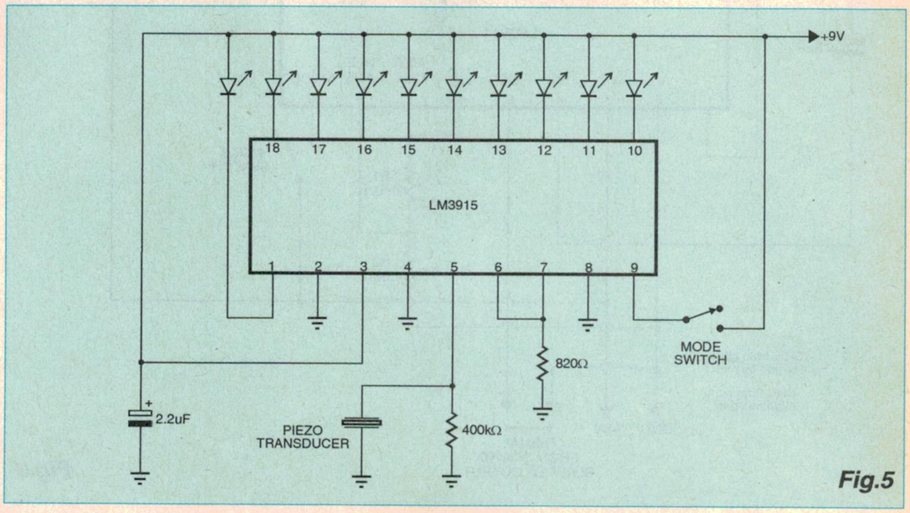
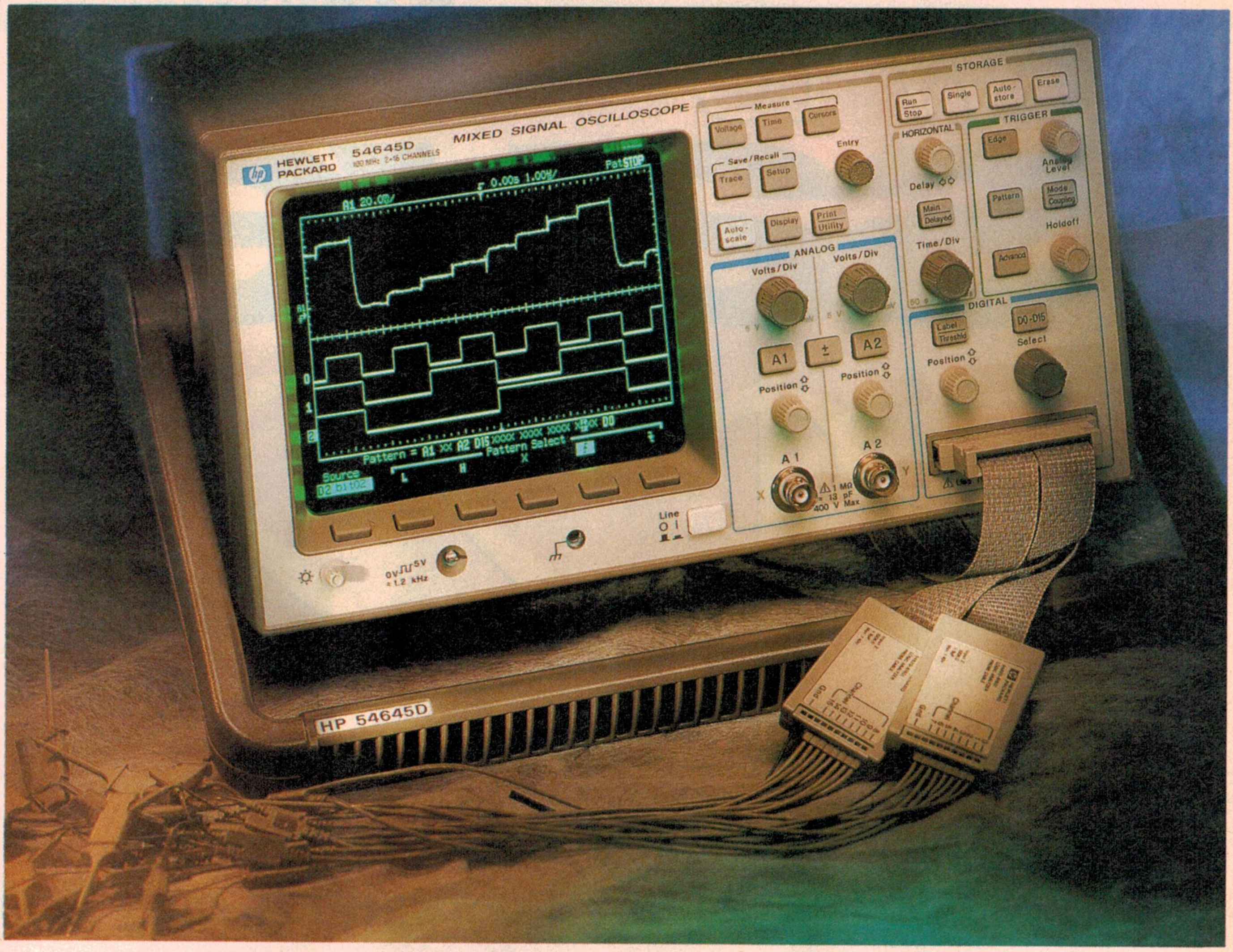


Fig.5

Exclusive hands-on preview:



HP's new 54645D 'mixed-signal' DSO

Hewlett-Packard has just expanded its 54600 line of lower priced digital scopes with two new models: the 54645A dual channel 100MHz bandwidth 200MS/s DSO, and the 54645D 'mixed-signal' DSO — virtually the same instrument with a built-in 16 channel logic analyser. Both instruments feature HP's new 'MegaZoom' technology, which combines deep sample memory with revamped acquisition and waveform display processors. Here we look at the very flexible 54645D.

by JIM ROWE

Ever since they launched their 54600 series of attractively priced DSOs in early 1991, Hewlett-Packard have been steadily adding further models. Last year they even added a 16-channel Logic Analyser, the 54620A (reviewed in our June 1995 issue), and its brother the 54620C with full colour display. Earlier this year they also announced the impressive 'high end' 54615B and 54616B, offering respectively 500MHz bandwidth with 1GS/s sampling, and 1GHz bandwidth with 2GS/s sampling.

Now they've added a further two models, a little different from one another but sharing the same basic model number. The new 54645A is described as the highest-performance DSO in the 54600-series 100MHz line, offering a maximum real-time sampling rate of 200MS/s and a memory depth of

1MB for each of its two channels. Its sibling the 54645D offers the same two 100MHz analog channels with 200MS/s sampling and 1MB memory depth, but goes further by adding 16 digital 'logic' channels, which are sampled at a maximum rate of 400MS/s and among them share a further 2MB of memory.

In a sense, the 54645D is almost as if HP had decided to combine the 54645A with the 54620A Logic Analyser, and squeezed them into the same case so they share a common timebase system.

HP has dubbed the 54645D a 'Mixed Signal' scope, and it's clearly intended to become an enhanced measuring tool for anyone who needs to develop or troubleshoot equipment with a mixture of analog and digital circuitry.

Logical idea

The idea of giving a scope a set of additional logic signal channels and enhancing its triggering facilities to include digital pattern recognition really makes a lot of sense nowadays. We're now well into an era where almost everything is either going 'all digital' or at least microcomputer controlled, and as a result equipment that *doesn't* have a mixture of analog and digital circuitry is starting to become hard to find. Anyone who's tried to troubleshoot in a lot of modern equipment can tell you that there are often situations where *neither* a conventional scope/DSO or logic analyser alone is all that much help. You tend to need *both*, and frequently operating in tandem...

To my mind this suggests that HP may well have hit on a winner with the 54645D. It could well turn out to be the first of a new breed of such instruments, which could easily become the successors to both conventional scopes/DSOs and low-end logic analysers for many people.

Hands-on trial

H-P very kindly made an advance sample of the 54645D available to us, and for the last couple of weeks I've been able to try it out. It came without any manuals (they hadn't been finished at that stage), but this wasn't a problem. In fact it gave me a good opportunity to see just how 'user friendly' the instrument really was — with no manuals to help out. More about this shortly.

All I had to guide me, apart from the instrument itself, was a copy of the press release announcing both new models, and some background material on the new technology incorporated in both of them. But that was enough; because it soon became clear that quite apart from the logic analyser functions built into the 54645D, both new models represent a significant step forward in terms of basic analog performance compared with the earlier 100MHz models in the 54600 family.

Probably the most obvious feature is that whereas the earlier models had a maximum real-time sampling rate of 20MS/s, the new instruments have increased this by a factor of 10, to 200MS/s. Apart from anything else, this means that the nominal bandwidth in single-shot mode (where real-time sampling is the only option) now jumps from 2MHz to a much more useful 20MHz.

Like the earlier models, the 54645A/D still use random equivalent time sampling in repetitive waveform mode. This means that the effective sampling rate for repetitive waveforms is considerably higher than 200MS/s, giving both higher waveform resolution and faster waveform capture.

"...almost as if HP had decided to combine the 54645A with the 54620A logic analyser, and squeezed them into the same case..."

In addition, the new models feature much deeper sample memory than the earlier models: 1MB for each analog channel (the earlier models only have 2KB/4KB). Until now this kind of sample memory depth has only been available on much more expensive DSOs, and the added depth brings some important benefits. One is that the scopes can store more high-resolution signal data, in single-shot mode.

For example even at the top real-time sampling rate of 200MS/s (i.e., one sample every 5ns), each channel memory can store a full 5ms of signal. This means that after capturing a single-shot event, you can 'pan' anywhere along the 1MB of samples, and 'zoom' in to inspect any particular part of the waveform — with an ultimate resolution of 5ns. Very nice indeed!

Another important benefit of the increased memory depth is that in repetitive waveform mode, the scopes don't have to 'change down' to a lower effective sampling rate, as soon as you drop to a lower timebase setting.

This is a problem with many DSOs, where they can only actually sample at their top sampling rate on the fastest timebase settings — because they simply don't have enough memory to store the larger number of samples needed to span a longer sweep time. The only way they can cope with slower sweep rates is by sacrificing sampling resolution, by dropping down to a lower effective sampling rate. The nett result is that lower-frequency signals and events are not captured with the same resolution, and you can easily either 'lose' important glitches altogether, or get serious distortion of any high-frequency components present (due to aliasing).

Of course all digital scopes have to drop to a lower sampling rate *eventually*, on the lowest sweep speeds. But with larger memory depth, like the 1MB in the new HP 54645's, this can be deferred until you get to much lower sweep speeds. For example the 54645's apparently sample at the 200MS/s rate right down to the sweep speed of 500us/div, and are still sampling at 20MS/s at a sweep speed of 50ms/div.

To allow the new scopes to handle the much deeper sample memory and the new 'pan and zoom' functions, H-P's engineers have developed what they call 'MegaZoom' technology. They haven't as yet released much detail on exactly how this works, but as far as I can see it has involved revamping both the signal acquisition processor (between the ADCs and the sample memory banks), and also the display processor (after the memory). The 54600 series scopes already had a total of three internal processors, with the third being a 68000 which looks after the front panel and external data communications.

In the case of the 54645D there's also a fourth processor — a second signal acquisition processor which is dedicated to the logic analyser inputs. These inputs also have a second 2MB of sample memory, which can be allocated according to the number of logic channels in use. If only eight channels are used, they can use the full 2MB — allowing records of 2 million samples. However if the full 16 channels are enabled, the 2MB is shared among them and the record length drops to 1M samples.

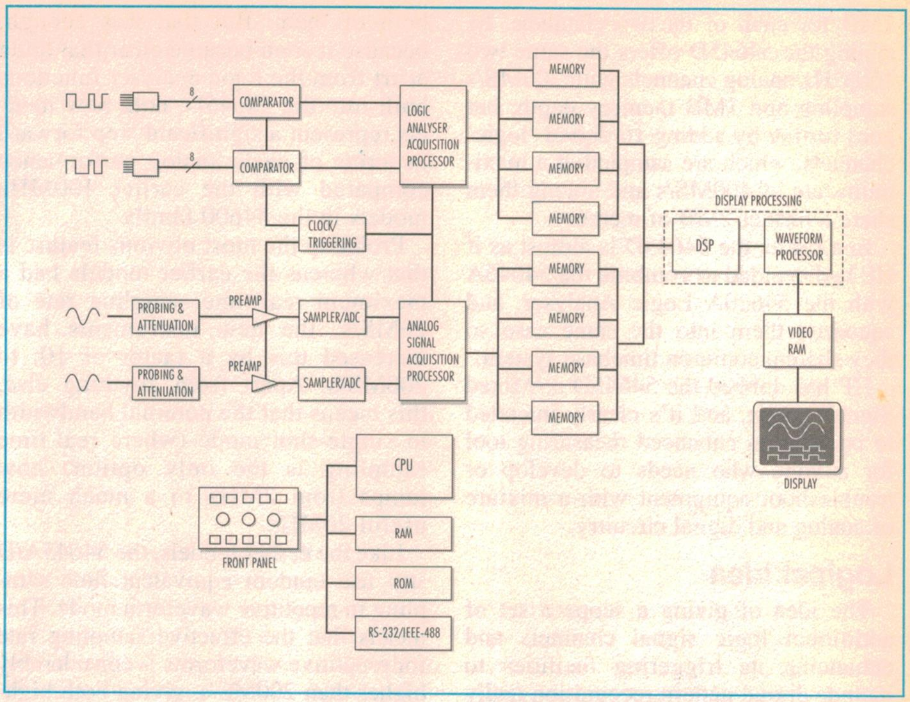
The new display processor handles the waveform and display processing from all of the acquisition memory, and also provides the new post-acquisition 'pan and zoom' functions. It not only manages to do all this, but at the same time *doubles* the waveform display speed: the 54645D refreshes the screen display at up to 3M sample points per second, compared with the 1.5M points of the earlier models.

Oh — and it also provides an optional vector plotting facility, which hasn't

HP's new 54645D

been available on the other 54600 models either. This is particularly worthwhile when you are working at the top sample/sweep speeds in single-shot mode. With the earlier models, you could end up with a waveform displayed as separated dots, one for each sample; now you can 'join the dots' to make the estimated waveform more visible. The display update rate drops to 60 screens a second with the vectors being calculated and displayed, but that's still more than acceptable.

As mentioned earlier, the 'analog' and 'logic' sections of the 54645D share a common timebase and triggering system. And the nice thing about this is that the integration has resulted in an instrument that's surprisingly intuitive to operate. In fact it's driven very much like a conventional delayed-timebase scope; even when you're using the post-acquisition 'pan and zoom' facilities to examine a single-shot recording, you do this simply using the same 'Delay' and 'Time/Div' controls that are used for achieving similar results in repetitive mode. And that's because this is the way those functions are actually *achieved* in repetitive mode, too — in order to get the highest performance from the acquisition system. The 'Main' and 'Delayed' timebases are in fact both implemented by the post-acquisition processor, and simply display the same captured data at a different rate and with an adjustable delay between their starting points.



A simplified block diagram of the HP 54645D Mixed Signal Scope. There are a total of four internal processors, with separate acquisition processors for the two analog and 16 digital input channels.

Done Transparently

But the important nett result, as far as the user is concerned, is that it's all done transparently and without any increase in operating complexity...

Of course the most obvious difference, as far as the 54645D is concerned, is that the signal capturing and triggering facilities are a lot more flexible. For example you have full control over how many of the instrument's 18 inputs are displayed; you can use it as a single- or dual-channel analog scope, as an 8- or 16-channel logic analyser, or as a mixed signal instrument with virtually any combination of the analog and digital inputs.

Needless to say when all 18 channels are in use and being displayed the screen does get a little crowded. But I suppose that can't be helped — there's a limit to just how much you can pack into a 255 x 500 pixel display on a 165mm-diagonal screen.

The triggering facilities are particularly impressive. Standard edge triggering can be from the rising or falling edge of any of the 18 channels, and there's a choice of Auto, Autolevel or Normal modes. Triggering holdoff can be adjusted anywhere between 200ns and 25 seconds, and there's a choice of DC or AC coupling with optional HF, LF or noise reject filtering.

In addition, you now have the ability to trigger on any pattern of high/low/'don't care' logic levels, or rising or falling edges — across any or all of the instrument's 18 inputs. And if that's still not flexible enough, you also have the ability to set up two pattern triggering terms (P1 and P2) and two edge triggering terms (E1 and E2), and combine these using a logical AND or OR function, or other functions including Then, Entered, Exited or Duration. Here's where the 54645D will *really* prove its value in mixed-signal circuitry!

But that isn't all — there's more. Glitch triggering, for example, where you can set the 54645D up to trigger on events shorter than, longer than or within a specified duration (minimum 8ns), with either rising or falling polarities, and again across any of the 18 inputs.

Finally, there's also TV-mode triggering from either of the two analog channels, with the ability to trigger on either field of an interlaced NTSC or PAL signal, or from the line sync. A handy feature for anyone working with video gear, and from memory not available on any of the other 54600 series models.

Of course the 54645D also provides pretty well all of the features of the existing 54600-series scopes. There's a good range of both automatic and cursor-based measurements, covering both voltage and time related parameters, plus that great 'Autoscale' button which lets you quickly get a handle on signals about which you initially know very little...

Needless to say the 54645D is also fully compatible with the range of add-on communications and enhancement modules developed for the earlier models in the 54600 series. Hence it can be fitted with the 54650A HP-IB Interface, the 54652A RS-232C/Parallel Printer Interface, the 54655A HP-IB Test Automation Module, the 54656A RS-232C Test Automation Module, or the 54657A or 54659A Measurement/Storage Modules, featuring FFT analysis as well as I/O interfacing and test automation. It's also compatible with the HP 34810A BenchLink software.

Our reactions

After using the sample HP 54645D Mixed-Signal Scope for a couple of weeks, I confess I'm impressed. And probably the two aspects of the instrument which impressed me most are (a) the way it combines so many features of a DSO and a logic analyser, and (b) the advan-

tages that have accrued from the new deep memory and MegaZoom technology.

In practice you tend to take the additional 'logic analyser' facilities of the 54645D for granted, probably because they've been integrated so intuitively with the standard DSO facilities. They're simply *there*, as the ability to capture data from a further 16 digital channels when needed, and also the ability to trigger from virtually any single or complex event involving the 18 total channels. So easy to take for granted, yet so big a leap forward from the modest capture and triggering facilities of many conventional scopes!

Actually I suspect that another reason why it *is* so easy to take these enhanced facilities for granted is that they're such a timely and worthwhile addition to a normal scope. Like all good ideas, you find yourself asking why it hasn't been done before...

It's much the same with the 54645D's deeper memory, and the 'pan and zoom' facility provided by HP's MegaZoom technology. You very quickly tend to take this for granted, too — and here because it's been provided in such a transparent fashion. You drive the scope in virtually the same way as with previous models (and also traditional analog scopes), so there are no new driving techniques to learn.

There are times, though, where you suddenly become aware of the advantages of that combination of 200MS/s real-time sampling, 1MB of memory depth, and the MegaZoom 'pan and zoom' facility. For example I was using the TV triggering mode to examine a video signal, and tried a single-shot capture triggering on Field 1. After capturing the signal I could then pan forward through the captured field by up to 56 lines (up to 3.56ms after the trigger), or back into the previous field by up to 1.41ms, and then zoom in anywhere to examine the captured waveform in any detail, up to the maximum resolution of 5ns/div!

This made it exceptionally easy to examine the VITS test signals in lines 17 and 18 of the vertical blanking interval, for example.

On the whole, then, I have to congratulate Hewlett-Packard's T&M designers yet again. The idea of effectively combining a DSO with a logic analyser to produce a 'mixed signal' scope has great serendipity, and in the HP 54645D they seem to have realised this goal in a very intuitive manner. I'll be very surprised if it doesn't become very popular, and similar instruments don't start appearing from H-P's competitors.

Did I miss not having the manuals? No, not really. They might have been useful reference material while I was writing this review, but in terms of actually driving the HP 54645D they weren't really necessary. Pretty well every aspect of the instrument's operation was either so similar to previous scopes, or so easy to work out that the absence of manuals was barely noticeable. Which is a good 'acid test' of the instrument's ease of use, wouldn't you say?

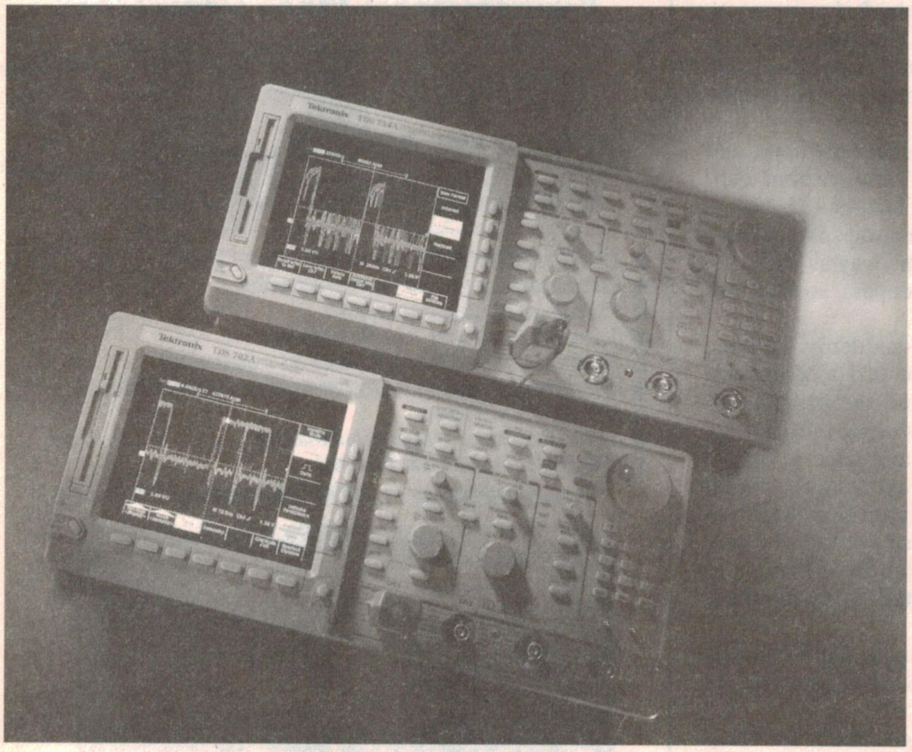
I guess the only thing about the HP 54645D that I'm less than enthusiastic about is the price. It's quoted at $7200, compared with $4904 for its sibling the 54645A. So for the present at least, only those in fairly affluent organisations will have the pleasure of using one. The rest of us will have to wait a while, I guess, until demand grows so H-P can ramp up production volumes and hopefully lower the cost...

My grateful thanks to Cate Rejman and Steve Grandis of H-P Australia, for providing us with the opportunity to try out the HP 54645D, and also for providing the information I needed in preparing the review.

Further information on the 54645D, 54645A or indeed any other scopes in the popular 54600 range is available from H-P's Test & Measurement Organisation, on 1800 629 485. ❖

NEW PRODUCTS

New Tektronix DSO has 1GHz bandwidth



Tektronix has announced two additions to its InstaVu acquisition family of digital storage oscilloscopes — the TDS782A and TDS754A. The TDS782A features a bandwidth of 1GHz and a sample rate up to 2GS/s on two channels. The TDS754A features a 500MHz bandwidth, four channels, and sample rates up to 2GS/s (1GS/s all four channels). Both oscilloscopes include Tektronix's proprietary NuColour display.

Combining a high-speed acquisition memory with a high-speed display rasteriser, InstaVu acquisition technology is claimed to deliver fast isolation and capture of unpredictable and rapidly changing signals containing infrequent glitches, metastable behaviours and time jitter.

The new scopes feature an intuitive user interface. A range of advanced triggering modes, including a new time-out mode, let the user select various conditional parameters which define the triggering event. Channel deskew increases the accuracy of timing measurements by compensating for external timing errors.

The Dual-Window zoom capability permits a simultaneous view of the acquired waveform in one window and zooming in on a specific area of interest in the other. Over 20 different printer drivers are available to print waveforms and screen images for later analysis. A complete range of compatible probes and accessory products are also available.

For further information circle 245 on the reader service coupon or contact Tektronix, 80 Waterloo Road, North Ryde 2113; phone (02) 888 7066.

Handheld meters measure light, colour

The TekLumaColor family from Tektronix comprises two photometers and their eight interchangeable heads. Each head transforms the handheld meter into a precision photometer, radiometer or colourimeter.

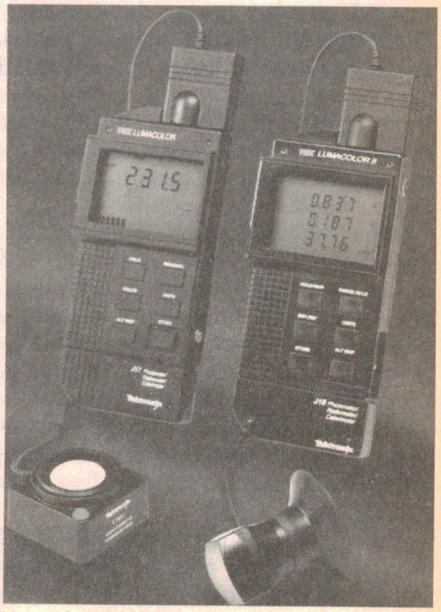
The meters are made with a rugged exterior to protect against shock and vibration. They are microprocessor controlled and can operate for 30 hours on a 9V battery, or from an optional AC power supply. Benchtop features such as RS-232 ports allow automatic testing and data recording.

The J18 TekLumaColor II has a J1810 chromaticity head and is mainly for testing, calibrating and adjusting colour displays. The unit stores 10 reference settings and is calibrated at D6500 for accurate white light readings. It offers full RS232 control, analog output capabilities and RGB bar graphs for calibration.

Where real-time colour isn't critical, the J17 can be used. Its features included auto-range, auto-zero, hold, colour coordinate conversions and US to metric conversions.

The heads provide measurements for luminance, illuminance, chromaticity, irradiance, luminous intensity and radiant intensity. Measurement applications include CRT displays, flat panel and projection displays, photographic equipment, infrared LEDs and lasers.

For further information circle 252 on the reader service coupon or contact Emona Instruments, PO Box 15, Camperdown 2050; phone (02) 519 3933.

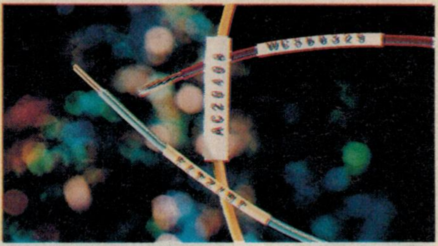


Two-sided wire markers

The new two-sided printable Permasleeve wire markers from Brady Australia are claimed to provide a significant reading advantage in wire panel and wire sleeve marking applications. Building on the original line of Permasleeve full circle wire markers, the new product has a print setup sheet and perforation options for different marker widths. Each marker is peeled from the carrier after printing and inserted on the wire for heat shrinking.

The supplied set-up sheet is attached to the wire marker carrier for printer text alignment, to avoid wasting several markers before the first one is printed. The markers are compatible with the latest revision of Labelmark, a computer program for two-sided printing.

The markers can also be perforated prior to shipment to allow printing of two to four smaller markers on one, full length marker. Legends printed on the markers are permanent. They are made of irradiated polyolefin, and meet a range of MIL specifications.

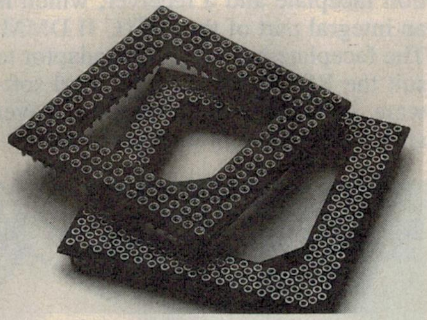


For further information circle 249 on the reader service coupon or contact Brady Australia, Industrial Products Division, PO Box 4064, Milperra 1891; phone freecall 1800 620 816.

Surface mount PGA sockets

An Augat GSM series (glass epoxy surface mounted) PGA socket, as opposed to a soldertail socket, allows additional surface-mount components to be mounted on the soldertail side of the PCB, thus maximising board space. It is also claimed to eliminate a wave soldering process by using the same vapour phase or IR soldering process used to solder all other surface mounted components.

The GSM series is an original Augat design (patented), introduced in 1987. It incorporates 'butt style' terminals



with the company's exclusive floating feature, for compliancy to the printed circuit board surface. The sockets have an insertion force of around 36g, and contacts are rated at 3A, with a contact resistance of 10mΩ.

The contact to contact capacitance is 1.0pF as per MIL-STD-202, method 305. The sockets can operate over a temperature range of -55°C and +125°C and will withstand humidity, vibration and shock to the relevant MIL-STD-1344 specification. The GSM series can be ordered to suit a wide a range of popular pin grid array footprints, and Augat can also supply a wide variety of application specific PGA and IPGA sockets. .

For further information circle 244 on the reader service coupon or contact Augat P/L, 3/1 Vuko Place, Warriewood 2102; phone (02) 9913 7100.

Calibration kit for Metrix ASYC II DMMs

The new Metrix SX-ASYC IIC calibration kit permits calibration of ASYC II series DMMs without the need to open the instrument. An interchangeable faceplate, which is part of the kit, is clipped in place of the DMM's faceplate and calibration is via an infra-red path between the calibration faceplate and a receiver, which is an integral part of the ASYC II DMM. The faceplate has a 25/9-pin adaptor to suit the RS232 port of a PC, and software includes a LabWindows driver and complete calibration software.

The ASYC II series DMMs are high-resolution, 50,000 count true RMS instruments with a bandwidth of 100kHz. They are suitable for AC, DC and AC + DC measurements and measure voltage, current, capacitance and frequency (to 500kHz), as well as pulse counts and percentage duty cycle. Positive and negative pulse width measurement are also provided. Other features include storage of last reading, peak capture and relative reading modes.

For further information circle 243 on the reader service coupon or contact Nilsen Technologies, 150 Oxford Street, Collingwood 3066; phone freecall 1800 623 350. ❖

Silicon Valley NEWSLETTER

Digital photography stars at the PC Show

If the product announcements at this year's massive PC Expo show in New York (835 booths, 130,000 visitors) are any indication, the next big growth area may well be digital photography.

Until now, digital photography has been limited to a relative small group of photo professionals and hobbyists able to afford the $1000+ cameras, and with enough time on hand to understand how to wire their PCs to develop a digital home photo studio. But that's all changing rapidly, with costs coming down and ease of use accelerating. Industry experts expect the market for home digital photography to take off in a big way starting in 1997.

Digital camera prices have fallen to the US$400 level and colour scanners and printers can be purchased for under $300. Software to edit photos is down to under $100, and new technology just around the corner will lead to dramatic improvements in tools and results, industry watchers say. Digital photography could reach the level of today's 35mm film cameras before 1999.

"Our engineers tell us we're in the beginning of the upslope of what we'll see from them", said Dan Crane, vice president of marketing for Epson America. Crane's firm showed its first photo scanner, selling for US$199, and a digital camera for $499.

Eastman Kodak, an early supporter of digital photography, despite its interest in the film-based photography market, introduced a digital camera for US$350, and is selling special inkjet-printer paper with photographic-print quality. The company also announced a technical standard called 'Flash Pix', with support from Hewlett-Packard and Microsoft, which will make it easy to transmit photographs as a form of electronic mail.

Microprocessor inventors honoured

Less than two weeks after the US Patent Office reinstated them as the co-inventors of the microprocessor, the three Intel engineers who built the 4004 chip in 1971 were inducted to the US National Inventors Hall of Fame in Akron, Ohio. The three, Federico Faggin, Ted Hoff, and Stan Mazor are among seven inventors chosen for this year's induction.

The Hall of Fame honours the creative genius of invention. Those it honours are chosen by a committee of representatives from 40 different US scientific and technical organisations.

As just one measure of the importance of microprocessors in today's society, in 1995 some 212 million microprocessors and 3.1 billion closely related microcontrollers were sold worldwide, according to the US Semiconductor Industry Association.

"I thought that the 4004 was a major innovation, a major step forward. However, I didn't think that in 25 years it would have the importance it actually has had", said Faggin, now chief executive of Synaptics in San Jose.

Work at Intel on the first microprocessor began in mid-1969 when Busicom, a Japanese calculator manufacturer (now defunct) asked Intel to design a set of chips for a family of calculators. Instead of a set of the five chips which would have created a computing system, Hoff thought that was too many chips to be cost effective and along with the others, set out to incorporate all of the functions onto a single chip.

Ironically, Busicom almost didn't agree to the proposal to reduce the set to just one chip. But eventually the company gave Intel a US$60,000 contract to develop the 4004 chip and eventually sold about 100,000 calculators.

In one of history's worst business decisions (in hindsight), Busicom, which owned the rights to the microprocessor, agree to sell the rights back to Intel for $60,000. That included the right to sell the 4004 in non-calculator applications...

GaAs chip set for portable phones

Portable telephones offering eight hours of continuous talk and up to 1000 hours of stand-by mode operation before

Milwaukee-based W.H. Brady has produced this handheld ID Pro Wire Marker Printer, designed to provide electrical contractors and installers with a handy way to print wire and cable marking labels at remote sites. It prints on a wide variety of materials, and is available in Australia from the firm's Australian office at 2 Pat Devlin Close, Chipping Norton 2170; phone (02) 821 1100 or fax 601 6048.

recharging are expected to become available in 1997, thanks to a new chip set featuring a high-speed gallium arsenide circuit, one of the first such chips to become available to the consumer market.

The chip set was developed jointly by TriQuint Semiconductor, which specialises in GaAs semiconductors for communications applications, and Pacific Communications Sciences Inc, a subsidiary of Cirrus Logic.

The chip set will enable portable telephone manufacturers to offer consumers telephones that either offer longer continuous talk or more compact designs when smaller batteries are used.

In order to design the GaAs chip set in a way that would not make its price prohibitive in the consumer market, the two companies modified the architecture of the semiconductors and designed a system with only one GaAs device.

Hitachi supercomputer is the fastest

Hitachi's SR2201 massively parallel supercomputer is currently the fastest supercomputer on the planet. So says the Oak Ridge National Laboratory in the United States.

The machine, which is built around 1024 RISC processors, achieves 220 billion mathematical operations per second (BOPS). That compares to the previous record of 170 BOPS by Fujitsu's top-of-the-line supercomputer.

The SR2201 is currently installed at the University of Tokyo.

The Top 20 in supercomputers is compiled and published twice yearly by Jack Dongarra, a computer scientist at the University of Tennessee and a researcher at the Oak Ridge research centre — part of the US Energy Department.

Faster memory chips on the way

A consortium of Japanese, US and South Korean semiconductor and computer makers have announced plans to develop new high-speed semiconductor memory technology that will vastly improve the speed at which PCs and other computing devices will be able to process data. The group said it seeks to develop and implement a new standard that will enable memory chips to send and receive data to and from the microprocessor two to five times faster than current memory circuits.

Companies that are part of the agreement include Fujitsu, Mitsubishi, Texas Instruments, Micron Technology, Apple Computer, Samsung Electronics and Hyundai Electronics.

A spokesman for the group said the new data transmission technology, which will allow for data speeds of between 500MB and 1GB per second. The first prototypes of the new chips are expected to be available by the end of this year, with commercial availability as early as 1997.

National resurrects Fairchild Semiconductor

In a move that pleasantly surprised nostalgia buffs in the high-tech industry, Fairchild Semiconductor, the granddaddy of Silicon Valley's semiconductor industry, was brought back to life after nearly nine years of being absorbed into the operations of National Semiconductor.

National, which acquired Fairchild from Schlumberger in 1987 for US$122 million, said it is spinning a large section of its operations off under the name Fairchild Semiconductor. National said it believes that separately the two operations will do better than if combined under one roof.

Kirk Pond, who will become Fairchild Semiconductor's new chief executive officer, will take some 6600 of National's 20,300 employees with him to run the operation. National is also taking a $280-to-$320 million write-off against earnings in the current second quarter in order to finance the move and send off Fairchild with sufficient operating capital.

Although its has been sitting empty since Fairchild was acquired by National, the new Fairchild Semiconductor will not return to its former headquarters in Mountain View, a facility that became known in the Valley as the 'rust bucket' for its rust-like exterior colours. Instead, the new company will take up headquarters in South Portland in Maine, the same town where the original Fairchild Camera & Instruments built one of its first chip plants.

The Fairchild operations that are being spun off represent some $650 million in annual revenues, about a quarter of National's total annual sales of US$2.6 billion. Halla said the operations that now comprise Fairchild were operating profitably.

The Fairchild division will make many consumer electronics ICs, as well as for portable phones and computers. They include logic, discrete and memory chips that are less profitable than the chips that are the heart of National's business. Chip factories in West Jordan, Utah, and in South Portland will become part of Fairchild, along with test and assembly plants in Cebu, the Philippines, and Penang. Malaysia National, meanwhile, will focus on analog and mixed signal chips, as well as National's microcontroller business.

Fairchild was founded in 1957 with $3500 in seed money from the camera company. The company's founders, historically known as the 'traitorous eight', were eight key researchers and executives who unexpectedly resigned from Shockley Laboratories, the company founded by the brilliant but tyrannical co-inventor of the transistor, William Shockley.

The Fairchild name holds a huge amount of esteem in Silicon Valley because so many of the company's 'Fairchildren' became founders and co-founders of dozens of semiconductor and other electronics companies — including Intel, National Semiconductor, Advanced Micro Devices, and LSI Logic.

TI names new CEO and chairman

As expected, Texas Instruments acted swiftly to replace Jerry Junkins, who died unexpectedly during a business trip to Germany. TI said it had chosen two of its senior executives to head the US$14 billion company. In a surprise move, however, TI's board passed over the firm's two highest ranking officers, including acting president Pat Weber.

Thomas Engibous, previously executive vice president and president of the semiconductor group, was named TI's new president and chief executive officer. James Adams, who has been a member of TI's board of directors for more than seven years, was named as the new chairman.

Weber was named as the new vice chairman. He had been acting as president and CEO after the death of Junkins.

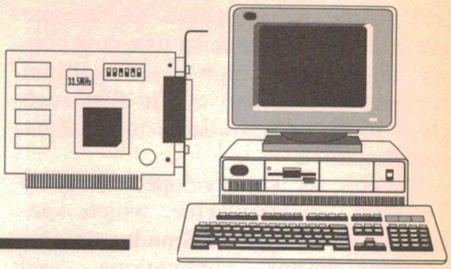
Samsung buys more of AST Research

Struggling PC maker AST Research is now just a fraction of a percentage point away from being majority owned by Samsung Electronics of Korea, following Samsung's purchase of US$60 million worth of newly-issued AST shares. That raises the firm's stake in the US PC maker to 49.9%. AST will also receive an additional $15 million from Samsung in return for the right to three families of semiconductor-related patents, with an option on other patents AST has applied for.

As part of the deal, AST named Samsung vice chairman and president Kwang-Ho Kim as its new chairman.

AST said it will use the Samsung money to help pay off a US$90 million debt to Tandy, which is related to AST's 1993 acquisition of Tandy's PC operations. The remaining US$30 million are expected to be paid off in cash and newly-issued stock. ❖

Computer News and New Products



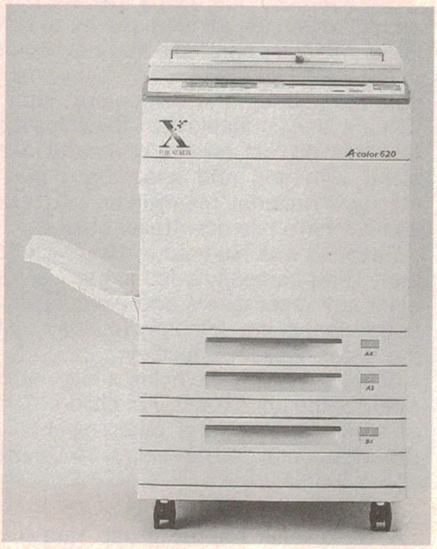
Colour laser printer

Fuji Xerox has released the Acolor 620 colour laser copier/printer. The new printer prints at six pages per minute in full colour mode and 24 pages per minute in black-only mode, at 400dpi and in 256 gradations.

The company claims the printer's image analysis control technology ensures clear reproduction of text on a coloured background. Light colours and different shades of a colour can be accurately reproduced, and image quality is improved by removing jagged text lines and enhancing fine lines. Because of its accuracy, the printer has an inbuilt counterfeit prevention feature which gives normally invisible imaging marks across every page as a way of detecting forgeries.

The printer can handle a wide range of paper types and sizes such as card stock, art film, coated paper and transparencies, on sizes from A6 to oversize A3. It comes with three front loading trays while a fourth optional paper tray, together with the bypass tray, enables a total paper feeding capacity of 1050 sheets. A multi-bin sorter and automatic document feeder are also available.

For further information circle 160 on the reader service coupon or contact Fuji Xerox Australia, 970-980 Pacific Highway, Pymble 2073; phone (02) 391 5300.

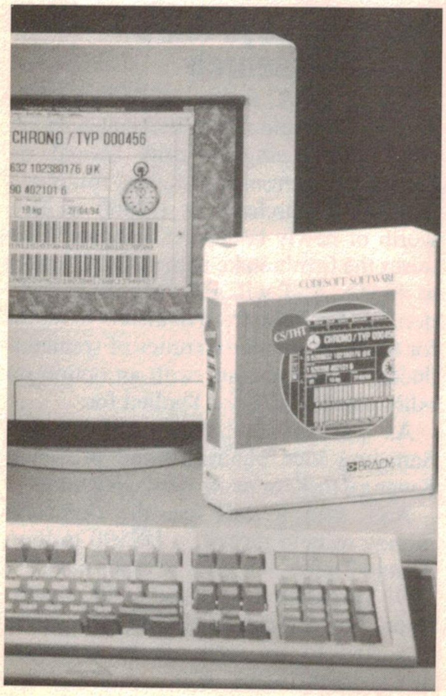


PCMCIA card has IEEE 488.2 control

IOtech has announced the Personal488/Card, a low-power type II PCMCIA instrument controller card that supports IEEE 488.2 compliant data transfer rates up to 1MB/s. The card can interface with up to 14 IEEE 488 instruments and features hot swapping — i.e., it can be plugged in or removed without rebooting the PC. The card is supported by IOtech's line of software drivers for Windows 3.x and DOS.

The card includes a 2KB FIFO between the PCMCIA bus and the IEEE-488 interface, so it can efficiently transfer data in large blocks. It offers complete talker, listener and controller functions, including the ability to monitor bus handshake lines and to detect changes on the SRQ line. The card is based on IOtech's new IOT7210T ASIC, an enhanced thin quad flat pack.

For further information circle 163 on the reader service coupon or contact Scientific Devices Australia, PO Box 163, Oakleigh Vic. 3166; phone (03) 9579 3622.



Software for barcode labels

W.H. Brady P/L has just released its latest version of Codesoft, claimed by the company as the most complete, user friendly barcode labelling software in Australia.

Codesoft Version 4.0 runs under Windows, and being DDE compatible, can import most database formats. Codesoft now comes with drivers for most thermal transfer printers, and can use all laser, inkjet and dot matrix printer drivers supported by Windows. The program supports all major barcode formats and industry standards. Also launched with the new version is free technical support. Free evaluation copies are available.

For further information circle 166 on the reader service coupon or call Brady Customer Service on freephone 1800 620 816 or freefax on 1800 805 076.

TPM749 microcontroller has Trackpoint software

Philips has announced a new licensing agreement with IBM that makes the IBM TrackPoint microcode widely available. The IBM/Philips agreement enables Philips to market TrackPoint software embedded within the TPM749 microcontroller.

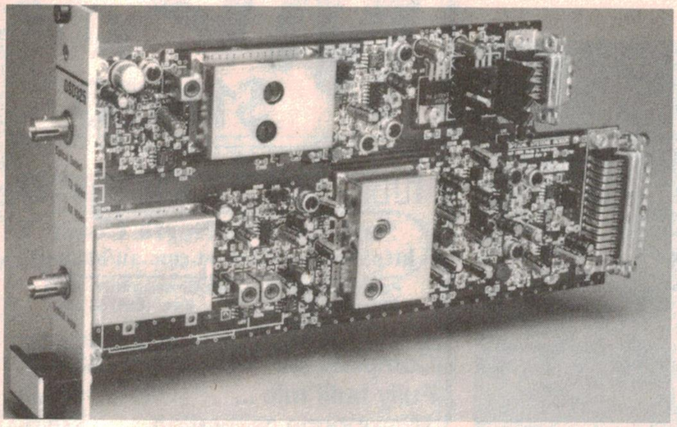
"TrackPoint microcode provides a precision, easy-to-use pointing solution", commented Duncan Tai, Australian manager for Philips Semiconductors. "The IBM TrackPoint pointing device, which is used in IBM ThinkPad notebook computers, eliminates the need for mechanical pointing devices such as mice and trackballs."

The TPM749, a low cost ROM-coded 80C51 microcontroller, comes with the IBM TrackPoint pointing algorithm and control code on-board. To implement TrackPoint, all that's needed is the Philips TPM749, an appropriate pointing stick (available from several manufacturers), and a few discrete components.

The TrackPoint device can be used in a variety of other applications such as PDAs, wheelchair controllers, game joysticks, industrial machinery, security cameras and surgical equipment.

For further information circle 165 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 805 4479.

Fibre optic modem for video and audio



Optical Systems Design has announced its 0SD325 fibre optic modem. The unit is suited for applications requiring audio, data and video distribution as it offers full duplex video, high quality program audio, data and 2-wire or 4-wire intercom. It also provides on-hook/off-hook signalling for the intercom.

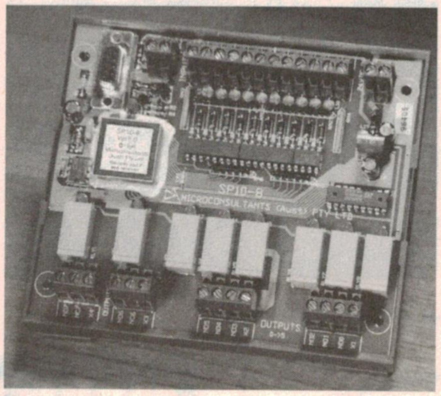
It normally operates over two singlemode or multimode fibres (one for each direction), but can be optionally supplied with a built-in wavelength division multiplexer for single fibre operation.

It is currently being used for campus distribution (and sourcing) of lecture material, CCTV systems using the reverse video channel for camera synchronization, deployable video/audio surveillance and command systems, and video conferencing. The modem is available as a standalone AC or DC powered module or as a card which plugs into a 19" rack mounting chassis.

For further information circle 168 on the reader service coupon or contact Optical Systems Design, Unit 7, 1 Vuko Place, Warriewood 2102; phone (02) 9913 8540.

Industrial control module

Microconsultants' new universal industrial controller module, the SP10-8, is optimised for control of small machines and for automation applications requiring timing, counting and a number of sequential steps. Its DIN rail mounting simplifies installation in one-off applications.



The controller is supported with Windows software, called SPLat/PC that incorporates on-line tutorial topics covering control basics and programming of the SP10-8, and general hardware applications information. The software features on-screen representation of inputs and outputs, single stepping and unlimited breakpoints. Programs are developed within the PC, then downloaded to the module for stand-alone operation.

For further information circle 162 on the reader service coupon or contact Microconsultants (Aust), 2/12 Peninsula Boulevard, Seaford 3198; phone (03) 9773 5082.

Speaker enclosure design software

Bodzio Software has recently released a new loudspeaker enclosure modelling program called BoxCad V1.0. The program is aimed at advanced audio hobbyists and audio engineers, familiar with acoustic impedance and electrical impedance modelling of loudspeaker drivers and enclosures.

The software can design and analyse any type of enclosure-driver(s) combination, including boxes with more than two chambers. It comes with 14 example models and seven calculators to facilitate conversion from Thiele/Small parameters to electromechanical parameters, and finally to acoustic/electrical impedance elements.

The program lets the user combine passive and active system frequency responses for exact modelling of powered subwoofers. All systems can be modelled in the frequency and time domains using built-in FFT/IFFT pair and modified nodal methods. BoxCad is a companion program and comes free with SoundEasy V1.1.

For further information circle 161 on the reader service coupon or contact Bodzio Software. PO Box 7136, Wheelers Hill 3150; phone (03) 9562 1224.❖

A/D D/A Converters

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ICL7136CPL	3 1/2 Digit A/D	$26.95
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TDA8444	Octuple 6 Bit DAC I2C	$7.10

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3470P	Floppy Read Amplifier	$12.20
AD705JN	Pico Amp Amplifier	$4.00
CA3130E	BIMOS Amplifier	$2.80
CA3140E	BIMOS Amplifier	$1.50
CA3140T	BIMOS Amplifier	$8.20
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LF351N	Single BIFET Amp	$1.40
LF353H	Dual BIFET Amplifier	$3.05
LF353N	Dual BIFET Amplifier	$1.85
LF355N	Single BIFET Amp	$1.75
LF356AH	JFET Op Amp	$25.50
LF356H	Single BIFET Amp	$2.85
LF356N	Single BIFET Amp	$1.80
LF357N	Single BIFET Amp	$1.95
LF398H	Sample and Hold	$8.10
LF398N	Sample and Hold	$5.50
LF412CN	Dual BIFET Amplifier	$2.65
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LF444CN	Quad BIFET Amplifier	$2.85
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LH0042H	FET Op Amp	$23.65
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LH740ACH		$38.95
LM10CLH	Lo Volt Amp & Ref	$8.90
LM10CLN	Lo Volt Amp & Ref	$3.95
LM10CN	Lo Volt Amp & Ref	$6.45
LM11CH	Precision DC Amp	$10.25
LM11CLN	Precision DC Amp	$2.80
LM11CN	Precision DC Amp	$3.80
LM12CLK	150 Watt Power Op Amp	$62.70
LM301AH	Single Amplifier	$1.55
LM301AN	Single Amplifier	$1.05
LM307N	Single Amplifier	$1.10
LM308AN	Super Gain Amplifier	$2.00
LM308H	Super Gain Amplifier	$3.55
LM308N	Super Gain Amplifier	$1.30
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LM310N	Voltage Follower	$3.75
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LM346N	Pgmb Quad Amplifier	$5.50
LM348N	Quad Amplifier	$1.15
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LM358AN	Dual Amplifier	$1.85
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LM359N	Dual Hi Speed Norton	$4.45
LM363H-100	Instrumentation Amp	$31.30
LM363H-500	Instrumentation Amp	$24.20
LM607CN	Replaces OP7	$3.65
LM613CN	Dual Amp,Comp,Ref	$4.80
LM709CN	Sngl Amplifier	$1.50
LM733CN	Diff Video Amplifier	$1.70
LM741CN	Sngl Amplifier	$1.00

LM747CN	Dual Amplifier	$0.90
LM748CN	Sngl Amplifier	$1.20
LM837N	Quad Low Noise Amp	$3.60
LM1458N	Dual Amplifier	$1.10
LM3080N	Transconductance Amp	$1.60
LM3301N	See LM324N	$1.60
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TL072CN	Dual JFET Amplifier	$1.75
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TL082CN	Dual BIFET	$1.75
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LM360N	Hi Speed Comparator	$6.55
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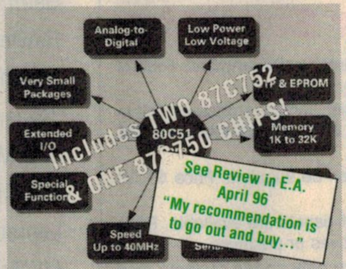
MB1505	50V 15A Bridge	$4.20

Here's the low cost way to get into Microcontrollers with the DS-750 Development Kit from Philips for only $159.90!!



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See April E.A. or earlier ads for full details

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MR851	100V 3A 200nS Diode	$0.80-
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BYW29-100	100V 8A Fast Rcvry	$2.65
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DS26LS31CN	Quad Diff Line Drvr	$0.60
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DS26LS32CN	Quad Diff Line Rcvr	$1.80
DS26LS34CN		$1.05
DS3486N	Quad Diff Line Rcvr	$1.70
DS3487N	Quad Diff Line Drvr	$1.70
DS3631N	Dual Drvr CMOS Comp	$3.40
DS3632N	Dual Drvr CMOS Comp	$3.00
DS3634N	Dual Drvr CMOS Comp	$3.75
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DS3695N	RS-485/422 Multi Tcvr	$5.85
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DS8640N	Quad 2 Input Rcvr	$2.15
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DS8820AN	Dual Diff Line Rcvr	$3.30
DS88C20N	Dual CMOS RS422/423	$10.85
DS8822N		$7.90
DS8830N	Dual Diff Driver	$2.35
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DS8834N	Tri-State Quad Tcvr	$2.50
DS8835N	Tri-State Quad Tcvr	$4.05
DS8837N	Hex Unified Receiver	$3.70
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DS75451N	Dual 30V-300mA Drvr	$1.15
DS75454N	Dual 30V-300mA Drvr	$1.05
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DS88C120N	Dual CMOS Receiver	$6.40
DS88LS120N	Dual RS422/423 Rcvr	$8.00
ICL232CPE	See MAX232CPE	
MAX232CPE	Supply DS14C232CN	$5.00

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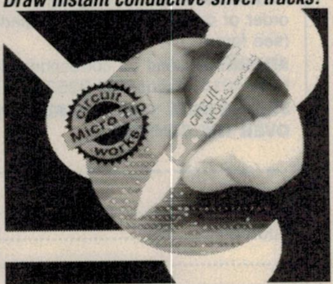
Circuit Works Conductive Pen

Repair broken circuit board tracks...
Add jumpers and links...
Draw instant conductive silver tracks!



Every circuit engineer or technician needs this handy pen! The 2200 liquid conductor is a specially formulated silver bearing polymer which makes electrical connections. Dries in 3 to 5 minutes at room temperature. Heat curing improves conductivity and allows solderable terminations (do not exceed 350°F for more than 5 s).

Pen contains approx 30m of connections and has a spring loaded tip to prevent clogging and drying.

To use simply shake pen for 20 seconds to mix conductor, press tip on work surface. Finger pressure on pen barrel adjusts flow rate. It's that simple! Can be used on flexible and rigid surfaces – circuit film, key pads, glass, laminates etc. 50-60% silver assay with 10-15micron particle size. Resistivity 0.2-0.05Ω/sq @ 1mil.

Cut re-work and repair time and cost! Speed prototype development! Circuit Works 2200 Pen **$23.95**

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READER INFO NO. 49

EA DIRECTORY OF SUPPLIERS

Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also, some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

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KEY TO CODING

A Kits and modules
B Tools
C PC boards and supplies
D Components
E IC chips and semiconductors
F Test and measuring instruments
G Reference books

Note that the above list is based on our understanding of the products sold by the firms concerned. If there are any errors or omissions, please let us know.

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ADVERTISING INDEX

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LASER POINTERS
Two new 5mW at 660nm (very bright!) laser pointers. One type in a very small flat plastic case, the other in a small metal cylindrical case fitted with a keychain. Both powered by 3 LR44 batteries and APC driver circuitry. Greatly reduced prices: **$55 ea**.

STOP SIGN KIT


A large PCB (165 x 58 mm) plus 54 high intensity red LEDs and 10 current limiting resistors that are surface mounted on the rear of the PCB. LEDs arranged to spell STOP. *VISIBLE IN SUNLIGHT*. Simple to add to a car's brakelight system, only two connections are needed: **$25** We also have a PCB and all onboard components for a direction arrow of similar dimensions to the stop sign. Has 28 high intensity amber LEDs. **$28** for two kits.

E-MAIL
Ask us to include you on our regular 'emailer' for updates of our latest specials and products: oatley@world.net

UV MONEY DETECTOR
Portable UV source. Commercial product for checking paper money. Has two AA batteries and an inverter to step up the voltage to power a 50mm long, cold cathode UV tube. Simple circuit. Inverter can dimly light a 4W fluoro tube. Takes about 250mA. Case 82 x 46 x 21mm: **$5** ea or **5 for $19**

GEIGER COUNTER KIT
PRICE BREAKTHROUGH! Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all onboard components, a Money Detector (see above), speaker and YES, the Geiger tube is included. **$30**

12V - 2.5W SOLAR PANEL KIT
US amorphous glass solar panels only need terminating and weather proofing. Includes clips and backing glass. Very easy to complete. Size: 305 x 228mm, Voc 18-20V, Isc 250mA. **$22 ea, 4 for $70**
Efficient switching regulator kit also available: suits 12-24V batteries, 0.1-16A panels, **$27**. Also available, simple shunt regulator kit **$5**

PIR MOVEMENT DETECTOR
Commercial quality 10-15M range PIR movement detectors. Second hand, tested and guaranteed, have relay contact outputs, a tamper switch and operate from 12V DC. Compatible with standard alarm systems. Includes circuit **$10** ea. or **4 for $32**

DISCO LASER LIGHT SHOW
Our 12V universal inverter kit plus a used 5mW+ helium-neon laser tube head, a used Wang power supplyand an automatic laser light show kit with dichroic mirrors: **$200**

STOP THAT DOG BARK
WOOFER STOPPER MK2, as in SC Feb '96. High power ultrasonic sweep generator which can be triggered by a barking dog. Includes solder-masked silk-screened PCB, all on-board components, transformer, electret microphone and transformer! **$39** Single Motorola piezo horn speakers to suit (one is good, but up to four can be used): **$14.** approved 12V DC-IA plugpack to suit: **$14**

SOLID STATE PELTIER DEVICES
12V 4.4A, can be used to make a thermoelectric cooler - heater. Basic info included. **$25** 12V DC fan **$8**

IR REPEATER KIT
Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

PLASMA EFFECTS SPECIAL
Ref: EA Jan '94. Produces a fascinating colourful high voltage discharge in a domestic light bulb, or light up an old fluoro tube or any gas filled bulb. The EHT circuit is powered from a 12V to 15V supply and draws a low 0.7A. Output is about 10kV AC peak. PCB and all on-board components (flyback transformer included), and instructions: **$28** (cat K16) Hint: connect the AC output to one of the pins of a non-functional but gassed laser tube, amazing results! The special? We supply a low power functional laser tube for an additional $14, but only if purchased with the plasma kit. Total price: **$42** (Includes instructions on getting the laser tube to produce a laser beam!)

MORE ITEMS & KITS
Poll our **(02) 579 3955** fax to find out how to get our item and kit lists. MANY MORE ITEMS AND KITS THAN THOSE LISTED HERE! *Ask for a list to be sent with your next order.*

FOG MACHINE
Mains operated fog machine: 700W, 3000 cubic meter per minute capacity, remote operation with lead supplied. Great for light shows and lasers! Low introductory price: **$300**

LED FLASHER KIT
3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50 ea, 10 for $12**

SIMPLE MUSIC KIT
3V, 3-pin IC plays a single tune. Two ICs that play different tunes, speaker and small PCB: **$3** or **10 for $25**

MAGNIFIERS - LOUPES
Four types (see review S.C. May 96). Small jewellers eyepiece with plastic lens: **$3**. Others in the range have two glass lenses, used where the loupe is placed close to the object being magnified. Focal point just below base of the loupe. Loupe with 50mm dia viewing area, 10 x mag: **$8**, 75mm: **$12**, 110mm **$15**.

VISIBLE LASER DIODE KIT
We have redesigned our 5mW 660nm visible laser diode kit so the PCB fits neatly into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **less than $100**

MINIATURE FM TRANSMITTER
Very small ready-made FM transmitter in a small black metal case. Powered by a 1.5V watch battery (included), has an in-built electret microphone. Tuning range: 88 to 108MHz (adjustable). Range approx 50m: **$32**

RARE EARTH MAGNETS
Very strong!!! Zinc coated. Cylindrical: 7 x 3mm, **$2** (G37) 10 x 3mm: **$4** (G38), toroidal 50mm outer, 35mm inner, 5mm thick: **$9.50** (G39)

VISIBLE LASER DIODE MODULE
Industrial quality 5mW/670nm laser diode module. Dimensions: 12mm dia x 43mm long. Includes visible laser diode, diode housing, APC driver circuit and collimation lens all factory assembled in one small module. Has superior collimating optic, divergence angle less than 1 milliradian: **$65**

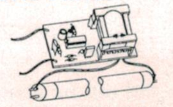
STEPPER MOTOR PACK
Pack of seven stepper motors. Save 50%! Includes 3 x M17, 2 x M18, 2 x M35, all new: **$36**

COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT
Kit will drive two 4, 5, 6 or 8-wire stepper motors from an IBM computer parallel port. Motors require a separate power supply (not included). Includes detailed manual and software (on 3.5" disk). NEW SOFTWARE will drive up to 4 motors (needs two kits), with linear interpolation across four axes. PCB 153 x 45mm, all on-board components, manual, software and two M18 stepper motors: **$44** This kit with the stepper motor pack above: **$65** Kit, no motors: **$32**

IR REMOTE CONTROL TESTER
Kit includes a blemished fibre optic coupled IR converter tube with either 25 or 40mm diameter window, and our night vision HT power supply kit. The tube responds to IR and visible light, and can 'see' the output of an IR remote control. **$30**

ARGON-ION HEADS
Used Argon-Ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. We provide a circuit for a suitable power supply. Dimensions: 35x16x16cm, weight 6.0kg. 1 year guarantee on head. Needs a 1kW transformer, available elsewhere for about $170. Argon head only: **$300**

STROBE KIT
Based on a flash unit from a disposable camera. We supply an additional PCB and components (plus instructions) to convert the flash unit into a low power consumption, highly visible strobe light (works off a 1.5V battery). Use it as a bicycle warning light, or as a strobe light (use several in a darkened room for best effect). **$6 ea or 5 for $25**

HIGH VOLTAGE AC DRIVER


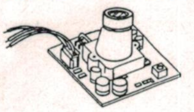
Produces a high frequency, high voltage AC for ionising most gas-filled tubes up to 1.2m long. It can partially light a standard 36W fluoro tube with two connections, taking less than 200mA from a 12V battery. Heat the tube filaments to get about 6W of light output. Includes PCB, small fluoro tube and components. **$18**

2 CHANNEL UHF KIT BARGAIN
304MHz with 1/2 million codes. Compact transmitter with keychain case, PCB, 12V battery and all components. Receiver kit includes PCB, all components (with 2 decoder ICs and 2 relays with 2A contacts). Range up to 50m. One 2 button Tx kit and one 2 ch Rx kit. Bargain at **$30**

SECURE IR SWITCH
Toggles a relay from an IR transmitter. Coded transmitter and receiver so a number can be used in the same area. Includes commercial one button transmitter, receiver PCB and parts to operate a relay (not supplied): **$22**

MASTHEAD AMPLIFIER SPECIAL
High performance low-noise masthead amplifier covers VHF-FM-UHF and is based on a MAR-6 IC. Includes two PCBs, all on-board components and a balun former. REDUCED PRICE: **$15** for basic kit. Suitable plugpack **$10**

ALCOHOL BREATH TESTER KIT
Has high quality Japanese thick-film alcohol sensor. Kit includes PCB, all components, meter movement: **$30**

CCD CAMERA BONUS SPECIAL


Tiny (38 x 38 x 27mm) PCB CCD camera, 0.I lux, IR responsive (works in total dark with IR illumination). Connects to any standard video input or via a modulator to aerial input. SPECIAL pack 1: standard or pinhole camera with bonus VHF modulator OR regulated 10.4V plugpack. **$150** SPECIAL pack 2: pack 1 PLUS video transmitter (see below): **$165**

VIDEO TRANSMITTER
Low power UHF TV transmitter with adjustable level audio and video inputs, power switch and power in socket. Needs 10 to 14V DC at 10mA. Set to Ch 31, can be altered. Video input accepts standard composite video (eg CCD camera), comes in small metal box and built-in telescopic antenna. Range typically 7 to 10m for internal TV antenna: **$25**

CCD CAMERA - TIME LAPSE VCR RECORDING SYSTEM
Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90.**

LOW COST IR ILLUMINATOR KIT
Allows a CCD camera or a night viewer to see in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs: **$40**

3-STAGE TUBE CLEARANCE
SC Nov. 95. 25mm 3-stage fibre optic night vision tube, works in starlight EHT supply kit and eyepiece. **$200**

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PO Box 89, Oatley NSW 2223
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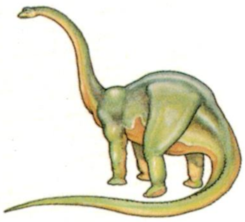
Announcing the creation of our $1,395* digital scope.

Allosaurus
133 million B.C.



Diplodocus
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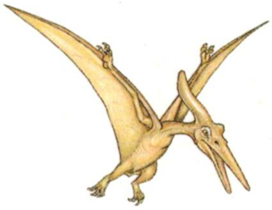

Pteranodon
65 million B.C.

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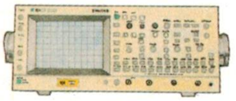
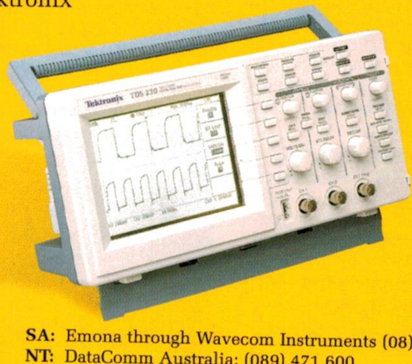
Triceratops
64 million B.C.



Analog Oscilloscope
1996 A.D.

An entire species could be wiped out by a single event: the introduction of the new Tektronix digital scopes — the TDS 210, a 60-MHz digital scope for $1,395*, and the next generation TDS 220, a 100-MHz digital scope for $1,995*.

At these analog prices, our digital scopes give you features no analog scope can match: automated measurements, screen captures, a choice of ten languages in the user interface and hard copy, not to mention operations up to 1 GS/s, more reliability, less bulk and increased productivity at your manufacturing, training and repair environments. For more proof on our theory of evolution, please visit http://www.tek.com or call our distributors on:.



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